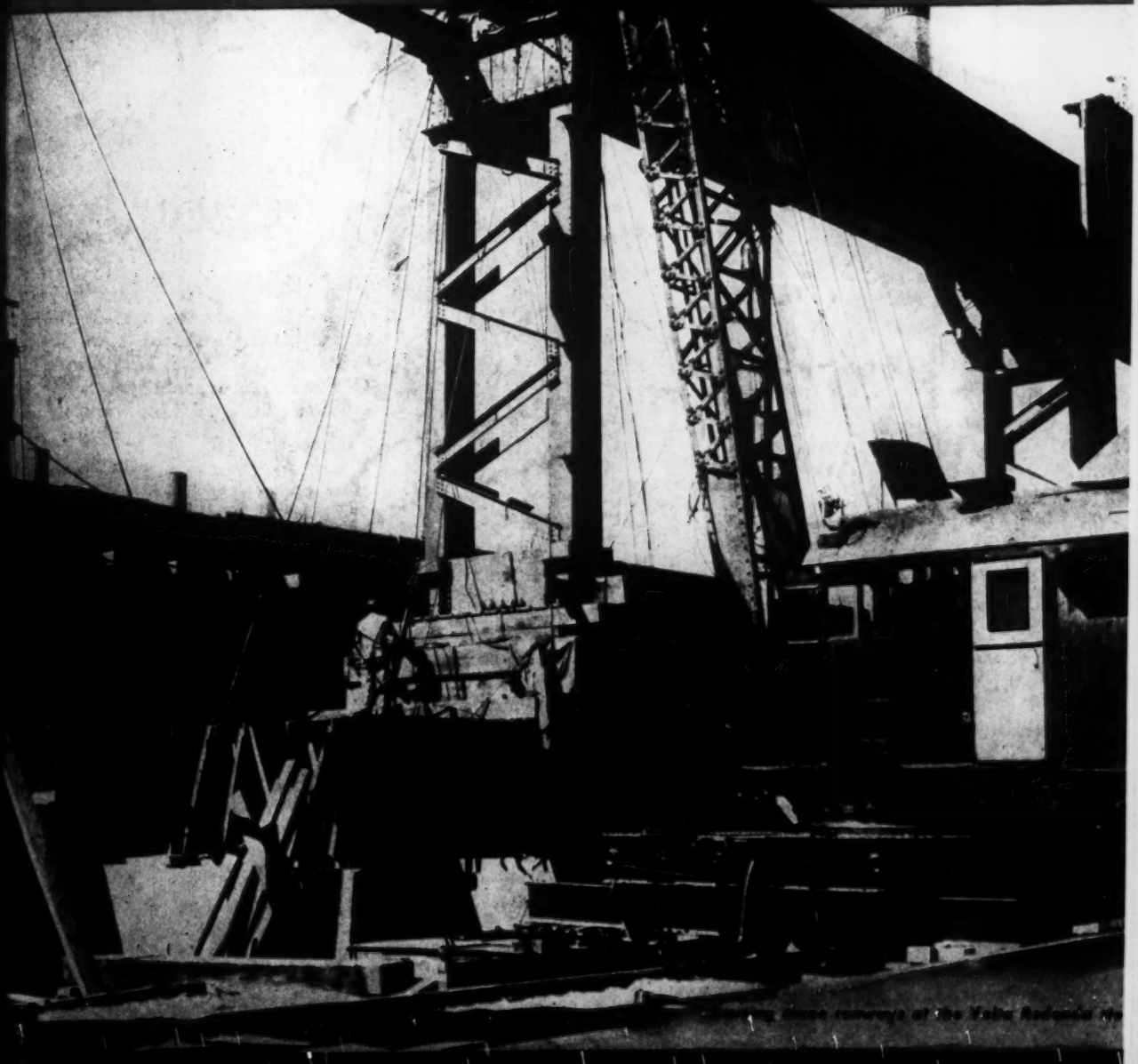
ENGINEERING NEWS-RECORD

JULY 25, 1946



In This Issue — UNUSUAL ERECTION PROBLEMS AT BRAZIL'S BIG STEEL PLANT • FLUORESCENT LIGHTING
IPMENTS • EXPLOSIVES PLANT BUILT AT GREAT SPEED • EXTENDING COMPRESSED-AIR OPERATIONS WITH HELIU

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Volume 137 • Number 4 July 25, 1946

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An index for Volume 136 (January-June 1946) will be published during the latter part of July. Copies will be mailed to subscribers who ordered an index for Volume 135. Subscribers who did not order a copy of that index or who have changed their address should return this coupon to

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Construction Trends

Construction Employment Rises Sharply in 1946

Construction employment rose rapidly in 1946 to reach an estimated total of 2,130,000 persons at the end of June, a gain of 75 percent over the close of 1945. Of this amount, 1,828,000 persons, 86 percent of all construction workers, are employed on private construction, according to the Bureau of Labor Statistics estimates.

In 1929, when the yearly average of construction employment reached its peak of 2,508,000 persons, 80 percent of construction workers were employed privately. However, during the depression year of 1933, construction employment dropped 61 percent from the 1929 level to a total of 976,000 persons, of which 54 percent were engaged in government construction.

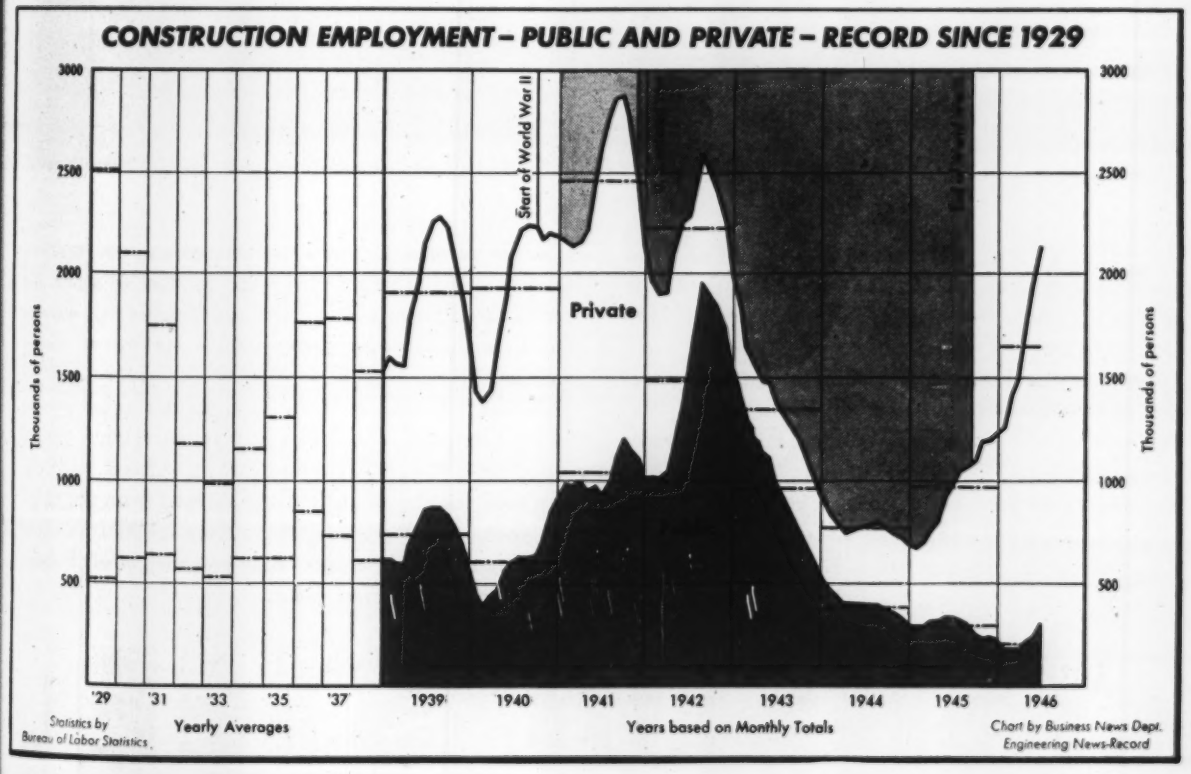
Construction employment, totalling 2,879,000, reached another peak in September, 1941, just prior to the United States' entry in World War II. At this time 58 percent were engaged in private construction work. Then, due to the need for rapid construction of additional Army and Naval stations, employment on public construction in August, 1942 rose to a high of 1,950,000 persons, 76 percent of all construction workers. Public construction employment continued to exceed private construction employment until the last half of 1944.

With the bulk of war construction completed, total construction employment dropped to a low of 671,000 persons in January, 1945. However, although public construction employment continued to drop, the number of persons employed on private construction rose to a total of 1,021,000 by the end of 1945, 52 percent greater than all construction workers in January, 1945. In January of this year, public construction employment, totalling only 179,000 persons, 14 percent of all construction workers, declined to its lowest point.

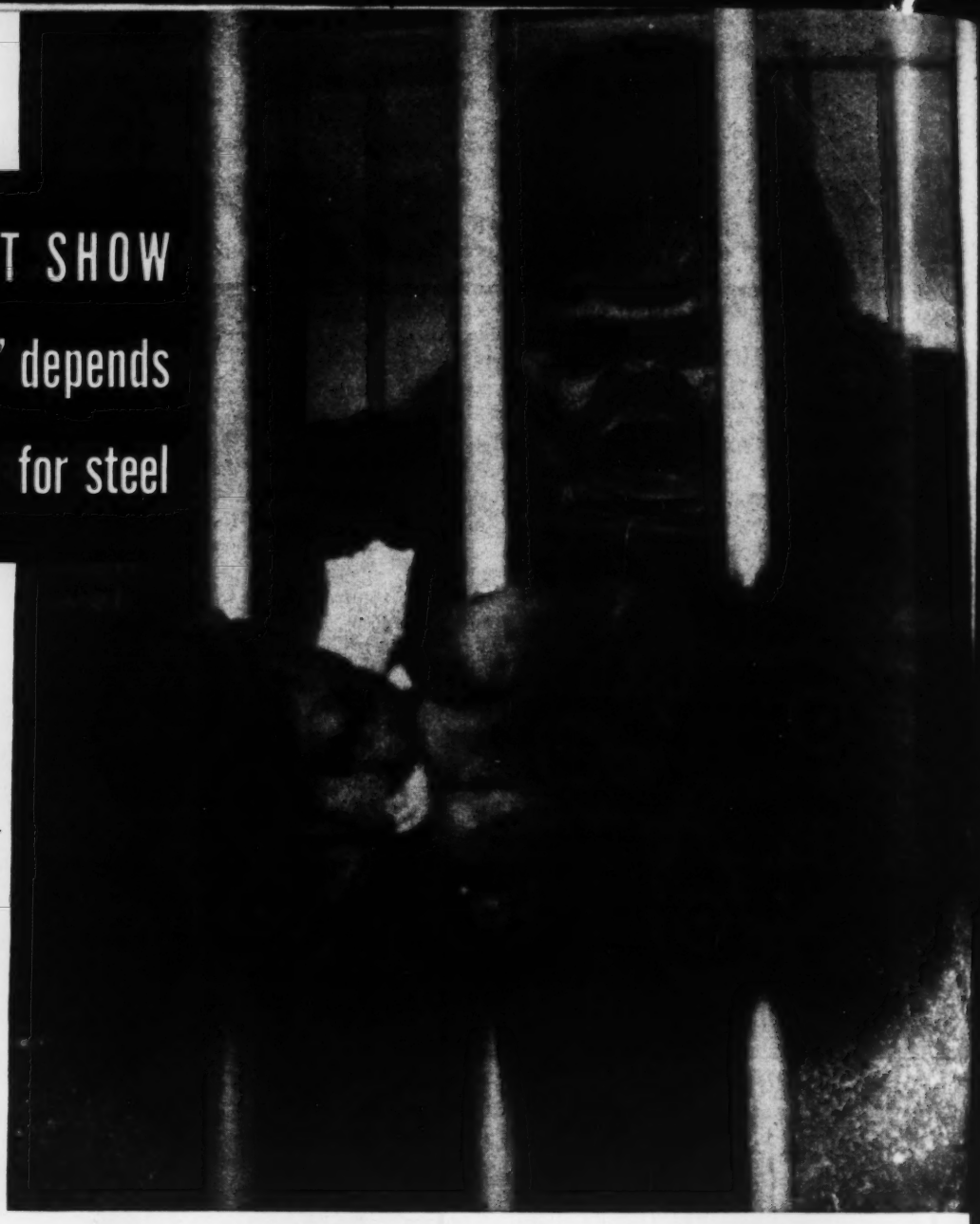
The recent sharp rise in construction employment, and particularly of private construction workers, illustrated by the accompanying table, indicates that we are rapidly approaching the danger point where skilled labor will not be available for the expanded construction program, unless apprentice training is speeded up.

Total Construction Employment

	1939	1940	1941	1942	1943	1944	1945	1946
January	1582	1420	2073	1960	1827	827	671	1267
February	1564	1367	2047	1902	1653	779	708	1406
March	1552	1418	2078	1912	1551	746	758	1497
April	1813	1657	2216	2106	1482	759	809	1718
May	1973	1872	2448	2251	1465	769	915	1942
June	2144	2090	2615	2292	1365	779	970	2130
July	2249	2210	2774	2453	1301	787	1043	
August	2276	2228	2863	2579	1254	790	1065	
September	2215	2220	2879	2469	1177	760	1097	
October	2035	2146	2698	2400	1083	741	1175	
November	1853	2186	2498	2262	996	720	1183	
December	1650	2173	2160	1987	905	683	1215	



"GREATEST SHOW ON EARTH" depends on Ryerson for steel



Photograph courtesy Ringling Bros. and Barnum & Bailey Circus.

Even the circus needs steel from stock, not only bars but structurals, tubing and reinforcing steel. All are products that Ringling Bros. and Barnum & Bailey secure from Ryerson stocks.

Whatever *your* business and whatever *your* requirements, you'll also find the nearby Ryerson plant a time-saving steel source. While many sizes are missing because of the steel shortage, stocks are improving daily. And often, when a needed steel is not available the Ryerson salesman can suggest a practical alternate.

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Construction Rises Sharply in 1946

Heavy engineering construction has increased in volume more rapidly in the first six months of 1946 than in any other six month period. Contracts for the first half of 1946, as recorded by *Engineering News-Record*, total $2,632,186,000, 200% greater than the same period of 1945 and 15% greater than construction in all of 1945.

The sharp rise in heavy construction is shown by the following table:

Cumulative End of:	1946	1945	% Increase
January	$348,277,000	$88,193,000	+216
February	596,302,000	197,709,000	+168
March	980,283,000	380,207,000	+158
April	1,516,473,000	520,586,000	+191
May	2,076,717,000	685,541,000	+203
June	2,632,186,000	876,155,000	+200

Construction volume for the average week of the first half of 1946 is $101,238,000 compared with $33,698,000 for the first half of 1945. The average week for June, however, rose to $138,867,000, 37% greater than the six-month average.

All recorded types of construction rose this year with the exception of public buildings, which declined 47% from the 1945 period, and federal work, which dropped 36%. Commercial building construction, totalling $1,042,741,000, showed the greatest gain this year with an increase of 2254% over the 1945 half-year total of $44,290,000. Commercial buildings comprised 40% of all construction in the last six months. This is largely due to the fact that the volume of mass housing rose to $832,574,000, 80% of all commercial buildings, and 32% of all construction in the first half of 1946.

ENGINEERING CONSTRUCTION REPORTED BY ENGINEERING NEWS-RECORD—FIRST HALF 1946

Minimum contracts reported: Waterworks, excavation, drainage and irrigation, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.
(Thousands of Dollars—000 omitted)

States	PUBLIC WORKS CONTRACTS					BUILDINGS				Federal Gov't. Work	All Construction		1946 Total 26 Weeks	1945 Total 26 Weeks	% Change 1945 to 1946
	Water-works	Sewer-age	Bridges	Earthwork Irr.-Drain.	Streets and Roads	Industrial	Commer-cial	Public	Un-classified		Private	Public			
Maine	29	.....	823	17	6,044	1,465	4,015	357	730	75	6,184	7,296	13,480	2,090	+545
New Hampshire	40	.....	.....	822	702	2,726	1,445	100	.....	735	4,171	1,664	5,835	476	+1,126
Vermont	.....	.....	388	2,429	718	150	150	242	.....	2,465	300	3,777	4,077	327	+1,147
Massachusetts	1,059	1,011	38	1,243	3,776	9,475	54,762	2,901	4,885	2,393	64,432	14,718	79,150	21,843	+262
Rhode Island	101	30	48	43	92	3,380	2,460	671	950	671	6,790	985	7,775	5,002	+53
Connecticut	720	1,107	2,480	1,001	4,414	14,335	20,398	4,051	1,225	2,747	35,476	14,255	49,731	8,090	+515
New England	1,949	2,148	3,777	5,555	15,746	31,531	83,230	8,322	1,790	9,086	117,353	42,695	160,048	37,918	+322
New York	14,765	1,603	7,680	7,148	9,162	15,017	90,492	11,257	12,051	10,748	105,911	63,264	169,175	20,737	+716
New Jersey	.....	777	1,532	1,319	3,827	15,740	16,778	757	1,675	2,306	32,678	9,727	42,405	15,478	+174
Pennsylvania	2,446	716	470	2,172	24,151	50,095	202,723	3,599	10,290	11,343	255,637	41,625	296,662	51,001	+482
Maryland	552	382	2,885	110	4,828	13,529	17,960	6,519	3,347	5,464	31,719	18,393	50,112	22,705	+121
District of Columbia	61	187	720	49	1,183	700	3,000	6,297	339	5,328	3,796	8,740	12,536	9,914	+26
Delaware	.....	.....	.....	.....	1,065	13,290	15,045	.....	158	133	28,360	1,198	29,558	550	+5,274
Middle Atlantic	17,824	3,665	13,287	10,798	44,216	108,371	345,998	28,429	27,860	35,322	457,501	142,947	600,448	120,385	+399
Virginia	762	774	127	133	16,125	4,203	1,300	734	1,356	3,367	5,759	19,755	25,514	28,699	−11
West Virginia	.....	30	348	1,838	3,558	6,800	925	.....	1,540	1,838	9,225	5,814	15,039	10,063	+49
North Carolina	1,154	458	1,841	71	13,718	7,219	4,222	5,842	5,953	5,741	16,196	24,282	40,478	13,606	+198
South Carolina	737	42	2,989	399	12,066	2,788	4,687	678	2,881	2,127	8,912	18,355	27,267	2,503	+989
Georgia	299	96	3,375	13,338	9,086	24,556	12,856	4,678	981	13,358	38,393	30,872	69,265	11,418	+507
Florida	1,014	40	1,349	5,046	4,541	4,660	7,865	1,973	7,783	7,127	13,636	20,635	34,271	28,234	+21
Alabama	584	1,079	812	289	10,462	4,376	27,879	5,460	935	3,576	33,155	18,701	51,856	23,038	+125
Mississippi	.....	.....	.....	3	5,055	1,271	3,138	519	539	418	4,948	5,577	10,525	4,584	+130
Louisiana	834	353	443	5,411	2,464	6,877	2,244	2,738	758	5,281	9,261	12,861	22,122	8,658	+156
Kentucky	133	.....	970	6,140	12,782	240	.....	2,334	886	6,411	1,126	22,359	23,485	10,194	+130
Tennessee	115	242	1,113	2,498	7,832	4,709	1,563	1,919	618	2,437	6,548	14,061	20,609	10,826	+90
Southern	5,632	3,114	13,367	35,146	97,689	67,699	66,679	26,875	24,230	51,681	147,159	193,272	340,431	151,823	+124
Ohio	2,917	822	2,551	3,639	10,093	23,456	30,455	2,966	17,299	5,644	71,116	23,082	94,198	29,509	+219
Indiana	477	649	985	294	6,831	12,046	5,744	3,681	1,106	399	18,565	13,308	31,813	18,239	+74
Illinois	1,193	8,087	3,327	1,323	10,159	35,647	20,536	7,210	5,417	2,833	58,649	34,250	92,899	51,453	+81
Wisconsin	670	2,637	680	273	12,389	9,579	5,845	792	3,332	940	17,534	18,663	36,197	13,516	+168
Michigan	192	364	876	264	4,696	26,214	4,382	16,489	756	702	31,239	22,994	54,233	25,423	+113
Middle West	5,449	12,551	8,419	5,793	44,168	106,942	66,962	31,138	27,910	10,518	197,043	112,297	309,340	138,140	+124
Minnesota	447	666	146	1,234	11,389	11,611	4,985	3,953	1,263	1,488	17,768	17,926	35,694	7,457	+379
Iowa	379	41	3,272	894	9,423	35,174	240	2,104	1,372	1,837	35,565	17,334	52,899	4,684	+1,029
Missouri	149	.....	990	5,410	7,684	22,688	17,458	1,116	4,320	5,661	44,419	15,396	59,815	13,129	+356
Arkansas	635	230	253	1,608	3,644	2,735	440	4,454	1,094	6,112	3,733	11,360	15,093	2,568	+488
North Dakota	.....	97	1,303	.....	3,056	110	.....	2,380	4,796	5,176	4,508	7,234	11,742	3,329	+253
South Dakota	.....	40	114	35	2,260	90	.....	396	961	16	1,051	2,845	3,896	952	+309
Nebraska	48	.....	.....	489	6,832	570	512	840	1,570	1,203	2,433	8,428	10,861	10,689	+2
Kansas	150	301	1,545	11,078	14,262	1,690	1,984	58	1,520	11,039	5,194	27,394	32,588	7,698	+323
Oklahoma	215	872	1,402	23,010	6,331	769	400	4,723	1,332	27,717	1,791	37,263	39,054	16,411	+138
Texas	6,220	7,243	2,166	9,111	24,410	43,610	82,338	17,048	35,365	12,848	156,680	70,831	227,511	111,836	+103
Montana	.....	56	339	1,134	2,401	738	800	1,902	842	3,204	2,380	5,832	8,212	3,099	+165
Wyoming	700	.....	356	10,162	2,739	.....	.....	204	327	10,483	210	14,278	14,488	2,135	+579
Colorado	380	150	.....	10,169	2,255	50	925	.....	.....	10,625	975	12,954	13,929	4,961	+181
New Mexico	348	.....	.....	890	6,452	40	300	745	195	2,462	375	8,595	8,970	9,282	−3
West of Miss.	9,671	9,696	11,886	75,224	103,135	119,875	110,382	39,923	54,957	99,871	277,082	257,670	534,752	198,141	+170
Idaho	.....	.....	93	2,509	1,225	7,479	250	.....	512	2,509	8,178	3,980	12,158	1,499	+711
Utah	79	29	64	538	1,671	1,104	1,125	486	134	840	2,229	3,001	5,230	5,074	+3
Arizona	.....	.....	.....	22,107	3,208	685	1,250	586	.....	22,907	1,935	25,901	27,836	4,258	+554
Nevada	.....	.....	.....	336	3,316	80	2,650	310	90	885	2,730	4,852	6,782	11,654	−42
Washington	1,824	475	2,189	6,353	6,624	9,391	26,378	3,581	8,037	11,878	37,318	27,534	64,852	30,168	+115
Oregon	1,490	641	1,164	1,343	6,026	11,299	80,966	1,330	6,065	6,174	94,480	15,924	110,324	14,684	+651
California	2,331	13,553	9,691	28,922	31,809	62,459	256,871	21,979	32,370	61,941	335,811	124,174	459,985	162,411	+183
Far West	5,724	14,698	13,201	62,198	53,879	92,497	369,490	28,272	47,208	107,224	482,601	204,566	687,167	229,748	+199
U. S. 1946 (26 weeks)	46,249	45,880	63,937	194,714	358,836	526,915	1,042,741	162,959	189,955	313,702	1,678,739	953,447	2,632,186	.....	.....
U. S. 1945 (26 weeks)	19,797	14,623	9,253	19,871	94,212	180,751	44,290	305,727	28,183	487,306	256,855	619,300	.....	876,155	.....
% Change '45 to '46	+134	+214	+591	+880	+281	+192	+2254	−47	+574	−36	+554	+54	.....	.....	+200
Canada, 1946	2,688	3,912	1,019	805	16,610	67,467	29,121	27,859	16,058	.....	107,988	57,551	165,539	56,284	+195
Canada, 1945	2,203	424	1,052	400	3,278	21,893	9,401	15,650	1,903	.....	31,809	24,395	.....	56,284	.....

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News of the Week

ENGINEERING NEWS-RECORD • JULY 25, 1946 • VOLUME 137 • NUMBER 4

Columbia River programs keynote ASCE convention

Spokane, Wash., meeting hears discussion of all phases of work—Board approves three-point policy on labor legislation, urges modification of Bloom bill

That the Columbia River has an important place in future national economy was clearly shown in papers and discussions at the annual convention of the American Society of Civil Engineers at Spokane, Wash., July 17-19. While many aspects of river development received attention irrigation was a principal topic and at the opening session a keynote paper on "National Reclamation" was presented by John W. Haw, director, agricultural development department, Northern Pacific Railway.

In pleading the case for continuing federal appropriations for arid-land reclamation, Mr. Haw said that (1) a major part of the cost of multiple purpose projects is repaid by irrigation and power revenue; (2) such projects expand the national tax base; (3) when completed, reclamation projects set up numerous opportunities for livelihood; and (4) contribution is made to a sound national economy.

Columbia Basin irrigation

Frank A. Banks, supervising engineer, Columbia Basin project, pointed out how the irrigation features of this million-acre project are related to other features (*ENR* May 16, vol. p. 780). Because irrigation demand comes in summer when the Columbia River flow is highest, the Grand Coulee Dam was not required for irrigation storage. However, power revenues from the dam, he said, will pay for three-fourths of the initial cost of the project's irrigation features. These features will require twice the man-hours used in construction of Grand Coulee Dam and will benefit by using low-cost, off-peak power to pump water for the canal system.

Land benefited by irrigation cannot ordinarily bear the entire capital cost and sometimes not even operation and maintenance costs, according to A. Griffin, manager, department of natural resources, Canadian Pacific Railway, Calgary, Alta., who discussed the evolution of irrigation in the Province of Alberta. However, large and expensive projects support towns and industries. Benefits thus accrue to the community and the nation to such an extent that part of the cost of irrigation projects should be borne by commerce and industry and by the people as a whole.

Columbia River studies

Continuous study has been given by the Corps of Engineers to development of the Columbia River since the 1925 act of Congress initiated the first of the "308 reports", according to O. E. Walsh, Colonel, Corps of Engineers, district engineer, Portland, Ore., speaking to the Waterways Division. In this 260,000 sq. mi. drainage basin rainfall ranges from 10 to 100 in. per year, he said, and discharges range from 50,000 to 1,160,000 sec.-ft.

Results of extensive study of economic justification for complete power developments of the Columbia River and tributaries were presented in another session by B. E. Torpen, head engineer, USED, Portland, Ore. Although 100 percent power development can be shown to be justified, Mr. Torpen thought that practicability would limit development to 30 or 40 percent. J. C. Stevens, past president ASCE, consulting engineer, Portland, pointed out that these studies concerned power only. He suggested that an analysis be made of all of the water shed's potentialities including equally important irrigation.

Columbia Basin power was also discussed in a paper by C. P. Hardy, Colonel, Corps of Engineers, district engineer, Seattle, Wash., (read by C. B. Lusk, engineer, Seattle District, USED) who said the theoretical total is some 50,000,000 kw. or twice the demand load of the entire U. S.

(*Continued on page* 56)

Ask bids on 82-mi Oakland aqueduct

Start of a $21,500,000 aqueduct was announced July 11 in Oakland, Calif., when officials of the East Bay Municipal Utility District called for bids on the first 10-mile section of the project.

The new 82-mi. welded steel line will bring water from the district's Pardee Reservoir (*ENR*, Oct. 31, 1929, vol. p. 705) to the east portal of the Walnut Creek Tunnel at a gravity flow rate of 50,000,000 gpd. It will parallel an existing line constructed in 1929, and will assure cities served by the district of a 92,000,000 gpd. gravity flow, which pumping could increase to 214,000,000. Present daily consumption on the system is about 106,000,000 gallons.

John S. Longwell, chief engineer and general manager of EBMUD, said $9,700,000 has been set aside for the new aqueduct, and that a $12,000,000 bond issue will be placed on the November ballot. The initial 10-mi. section, for which bids will be opened Aug. 7, is estimated to cost $3,000,000. Should the bond issue not carry, funds will be taken from earnings and from savings resulting from the elimination of present pumping costs, said to total about $500,000 per year.

The pipe will be encased in concrete and have a 67-in. dia. It will be installed in 30-ft. lengths, electrically welded on the job. Manholes, relief valves and blowoffs will facilitate repairs. Most of the pipe will be placed below ground with a 2-ft. fill, while 10 miles will be carried over a marshy delta area on pile-supported concrete bents. Submarine crossings of the San Joaquin River already exist.

Construction of the project is expected to take about two years from the time the first contract is let, according to engineers for the district.

NEWS IN BRIEF

In telegraphic form, here are latest news developments on the engineering and construction front during the week.

Construction — The *Albuquerque, N. M.*, school board is delaying its planned $1,200,000 building and improvement program until construction costs are lower . . . The Welch Grape Juice Co. plans a $750,000 fruit processing plant, at *Wenatchee, Wash.* . . . Work has started on a $300,900 medical center building at *North Hollywood, Calif.* . . . The B & O Railroad will erect a $1,500,000 roundhouse and terminal at *East St. Louis, Ill.* . . . *Mt. Vernon* and *Savanna, Ill.*, have been chosen as sites for two of the five 100-bed state tuberculosis sanitaria to be built for $1,000,000 each.

Highways—A new $14,500,000 low-level highway between *San Diego, Calif.*, and the Imperial Valley via Lyons Valley is being advocated by the engineering committee of the city and county and the San Diego Highway Development Association. The *Georgia* State Highway Department asked bids on approximately 40 state-financed road projects in 33 counties, to cost $2,161,065. . . . Plans are being discussed for a $5,000,000 bridge over the York River at *Yorktown, Va.* . . . The *Maryland* state roads commission awarded $6,731,790 in contracts in the first half of 1946.

Housing—The Heslop Building & Realty Co. has broken ground for 400 veterans' houses in *Cuyahoga Falls, Ohio* . . . The University of California, *Los Angeles*, is completing 308 two-room student apartment units. . . . Barrett & Hilp, contractors, are building a $150,000 plant at *South Hackensack, N. J.*, for the prefabrication of $8,000 homes to be sold for delivery within a radius of 80 miles. Five houses a day per shift are planned by this organization which built 500 houses in five months at Norfolk, Va. (*ENR* Aug. 13, 1942, vol. p. 212).

Water supply and sewerage—*Savannah, Ga.*, plans the construction of a $3,000,000 reservoir to supply water for industrial plants . . . Preliminary engineering studies for construction of relief sewers in the Blackstone-Clarendon district of *St. Louis, Mo.*, have been authorized by the Supervisory Committee of the Citizen's Bond Issue Committee . . . Contracts have been executed for water mains and sewer extensions at *Cairo, Ga.*, to cost in excess of $100,000 . . . *Dallas, Tex.*, will give first place to $13,000,000 worth of sanitary sewers over all other municipal construction in the next ten years . . . Officials of *Oakland, Berkeley, Alameda, Piedmont, Emeryville* and *Albany, Calif.*, July 15 approved a $22,456,000 sewage disposal system, to meet requirements for the next 50 years and to eliminate pollution of shore water. They also authorized a bond issue proposed to be put on the November 5 election ballot . . . A bond election has been recommended at *Phoenix, Ariz.*, to obtain funds for the expansion of the city's water system. . . . The Public Utility Commission has approved the acquisition by the Municipal Authority of *Clearfield Borough, Pa.*, of all the capital stock, waterworks facilities, rights and franchises of Clearfield Water Co. and all the physical properties, franchises and assets of the subsidiary Lawrence Water Co.

Miscellany—Voters at *Olympia, Wash.*, July 9 authorized the Port of Olympia to issue $300,000 in bonds for construction of a cold storage plant. . . . Employment of an engineer to prepare the application of *Clearwater, Fla.*, for the widening and deepening of passes between its harbor and the Gulf of Mexico has been approved by the Chamber of Commerce. . . . Grading and drainage work on the $1,750,000 Redbird airport at *Dallas, Tex.*, has been finished. . . . Circuit Judge G. Duncan Bellinger, ruled at *Columbia, S. C.*, July 11 that neither the state nor any of its departments may be sued for breach of contract. Judge Bellinger dismissed a complaint against the State Highway Department by Joseph W. Barnwell, Jr., who sought $5,328 for alleged breach of contract to construct certain bridges over the Little Pee Dee River.

Calendar of Meetings

NATIONAL

Building Officials Conference of America, annual convention, Peabody Hotel, Memphis, Tenn., Sept. 2-5.

REGIONAL

Ninth Annual Short Course for Water and Sewage Personnel, Louisiana, State University, Baton Rouge, La., July 25-27.

Interstate Commission on the Potomac River Basin, 5th annual meeting, Camp Ritchie, Md., Aug. 8-9.

American Shore and Beach Preservation Association, summer meeting. The Breakers, Cedar Point, Ohio, Aug. 13-15.

Georgia Water and Sewage Association, annual meeting, in conjunction with 15th annual Georgia Water and Sewage School, Georgia Institute of Technology, Atlanta, Ga. Sept. 16-18.

New England Water Works Association, 65th annual conference, Poland Spring House, Poland Spring, Maine, Sept. 16-20.

Millions authorized for state work in Florida

Of $10,082,152 available for state construction in Florida, work totaling $7,480,039 already has been authorized by cabinet boards.

Director C. H. Overman of the state improvement commission reports that there is an unencumbered balance of $2,602,113 available for construction of state buildings.

Indiana will spend $16,500,000 for parks

The Indiana Department of Conservation plans expenditure of $16,500,000 in its long studied program for acquiring three new state parks and the expansion and improvement of the 14 existing parks, according to Milton Matter, department director.

A total of $9,000,000 will be spent in establishment of the new parks which will provide additional public park facilities in central, northern and eastern Indiana.

The remaining $7,500,000 of the planned expenditure will be used on improvement of the parks already owned by the state.

No over-all allocation of steel is planned

The government is planning no overall allocation of steel, according to John D. Small, Civilian Production Administrator. In a recent statement, he cites sharp gains in steel output since the end of the coal and steel strikes, and a good outlook for industrial peace over the next six months as reasons for assuring industry that government controls on steel distribution could be held virtually to the current limited levels.

The current limited priorities assistance established by the Civilian Production Administration to relieve individual hardship cases and to eliminate bottlenecks in the Veterans' Housing Program must be continued through the fourth quarter, Mr. Small said. In addition, he stated that the steel industry would be expected to meet the needs for food production and transportation. He emphasized that regardless of what action is finally taken on price control, a means must be found to prevent geographical dislocation in the production and distribution of steel products which are in critically short supply. Among the foremost critical product problems, Mr. Small mentioned, are the production of nails, bale ties and galvanized sheets.

California Supreme Court ok's hiring of consultants by city works office

Court orders payment of fees to sanitary engineer in upholding city's right to go outside its departments for specialized aid

The legal right of San Francisco's director of public works to hire consulting engineers when he so desires was established early this month by a California Supreme Court order to the city comptroller to pay $10,000 to Clyde C. Kennedy, consulting sanitary engineer.

The payment is the first in a $77,000 contract signed between Harry Vensano, public works director, and the Kennedy firm for plans and specifications for the North Point sewage and sludge treatment and disposal plant at Islais Creek. The contract had been contested by the city's Civil Service Commission.

Vensano's action in going outside the city's engineering department was challenged last September when a taxpayer's suit was filed by civil service representatives in an attempt to prevent design work going to consulting firms (*ENR* Oct. 11, 1945, vol. p. 474). While the suit was pending, Comptroller Harry Ross refused to make the initial $10,000 payment due in December.

With the city facing long drawn-out court procedures and much needed construction work—for which funds were available—being held up, the Consulting Engineers' Association of California voted to provide $5,000 to obtain attorneys and were ultimately successful in taking the case directly to the supreme court through a petition requesting a writ of mandate (*ENR* March 21, 1946, vol. p. 394).

The case hinged entirely on interpretations given to the city charter as to Vensano's right to sign a contract without approval of the Board of Supervisors, the legality of such work going to others than bona fide civil service personnel, and the awarding of a contract without competitive bidding.

The court ruled in favor of the consulting engineer on all counts. Justice John Shenk's opinion said that only permanent official positions are classified as civil service and that persons employed for expert temporary services are exempt. On the director of public works' right to sign the contract, the opinion found that since the city charter gave the director "unquestioned express power to let contracts for the construction of the improvement, the power to obtain the plans and specifications therefore follows as a necessary incident."

As to competitive bidding, the opinion admitted that construction contracts must be advertised and bids called, but added that "it does not follow that strict compliance with that requirement must be maintained in procuring expert services to furnish plans and specifications." On this, Justice Shenk further wrote: "Advertising might bring many bids, but it is beyond peradventure that the lowest bidder might be the least capable and most inexperienced."

Describing Kennedy's firm as outstanding in its specialized field, the opinion said that the services for which the firm was engaged could not adequately be rendered by an existing department of the city.

The court's ruling was the signal for Director Vensano to launch more work in the city's postwar construction program. Already, a contract has been signed with San Francisco Architect William Merchant for work on a $1,250,000 juvenile detention home.

Albuquerque to expand its water facilities

Albuquerque, N. M., will install an 8,000,000-gal. steam turbine pumping unit for its municipal water works, according to City Manager Charles E. Wells. The cost of the unit is estimated at about $74,000. It would replace a steam reciprocating pump unit now worn out, and is one of 16 items which Wells recently listed in a proposed $966,284 water department expansion program.

Wells hopes the new unit can be installed before next summer to avert recurrence of the water shortage now prevailing in Albuquerque, caused mainly by the growth of the city during and after the war.

Plan $1 million job at Memphis

The city of Memphis, Tenn. has plans for more than a million dollars in street and storm drainage projects, in addition to proposed construction of sanitary sewers in new subdivisions.

The work planned includes: installation of underground drainage on Washington Street; widening and repaving Manassas Street, Dunlap Street and Jefferson Street.

Legal complications delay two Houston tunnels

Action on the building of the two tunnels under the Houston Ship Channel at Houston, Tex., (*ENR* June 6, vol. p. 887) is being held up until certain legal problems can be solved.

The state agreed to furnish $5,000,000 toward building the tunnel at Spillman Island but refused to furnish anything toward building that at Pasadena. A $5,000,000 bond issue voted by Harris County in 1944 provides for the construction of both tunnels, but no money from this bond issue can be used legally to construct either tunnel until the construction of the other is assured; and under the Texas law, no county can contribute money toward constructing a state highway—which the Spillman Island tunnel will be—except to furnish right-of-way.

Three-way pact needed

Before work can be started on the construction of the Pasadena tunnel, which will be built by the county and the navigation district, some way must be found for the county to contribute legally to the building of the Spillman Island tunnel; a way must be found for federal help to be obtained and to get an exact estimate of the cost of constructing the Spillman Island tunnel.

$8.5 million allotted for timber access roads

An additional $8,500,000 has been allotted to the Secretary of Agriculture for the construction of access roads to out-of-the-way government timber lands to boost lumber production for the Veterans Emergency Housing Program, Wilson W. Wyatt, Housing Expediter and Administrator of the National Housing Agency, has announced. With $2,000,000 allocated in June, this makes a total of $10,500,000 available for construction of access roads to standing timber on national forests.

The new roads are expected to add 90 to 100 million bd. ft. of lumber to this year's production and 500 to 600 million bd. ft. next year.

Conn. resumes road beautification

Every mile of the 3,000 miles of Connecticut state highways is to be cleared of objectionable growth in a resumption of a war-halted program by the highway department. Accumulation of sand deposited during icy periods will be removed. On the Berlin Turnpike from the Hartford by-pass to Meriden the median strip is to be returfed and grubproofed where Japanese beetles and other insects have caused much damage.

It is planned to plant 1800 shade trees and 2,000 conifers.

ASCE western meeting hears program for Columbia Basin development

(*Continued from page 53*)

Most of the future power needs of the region, in the opinion of T. M. Robins, Brig. Gen. Corps of Engineers (ret.), will be supplied by developments on the Columbia carried out by federal agencies for multiple purpose objectives such as flood control, navigation, irrigation and power development. Ocean-going barges, he said, will deliver freight as far up the Columbia as Pasco, Wash., and Lewiston, Idaho.

Canadian aspects of future Columbia River development were presented by Christopher E. Webb, district chief engineer, Dominion Water and Power Bureau, Vancouver, B. C., who reported eagerness for cooperation but said Canada has made less progress because field work did not start until 1944.

Discussion in the session on waterways brought out the following: Maintenance costs on the 114-mi. river channel from Portland to the sea was $700,000 last year during which 38,000,000 tons of freight moved through the channel; tonnage moving up the river beyond Bonneville Dam and in the first half of this year, with the fall wheat crop yet to come, was 40 percent above the 598,000 tons handled last year; Bonneville fishways costing some $7,500,000.

Cleaning up the Willamette

Long delayed cleanup of the Willamette River is now in sight, according to a paper by Ben S. Morrow, city engineer, Portland, outlining Portland's proposed sewage disposal system for which plans are completed and funds are now available. The control of pollution by industrial wastes and by smaller up-river cities can hardly be demanded prior to action at Portland but is sure to follow.

The severity of some of the waste pollution cases was illustrated by Fred Merryfield, professor of civil engineering, Oregon State College, with reference to a 9-mi. length of the Santiam River which has become a "biological desert" as the result of carrying excessive discharges of sulphite liquor from a pulp mill.

However, in the last two years, industries, particularly pulp and paper mills, have taken a much more cooperative attitude and Prof. Merryfield believes that within ten years a 50 percent reduction of industrial waste pollution can be expected.

A cannery which has spent as much as $6,500 in one season for sodium nitrate to keep down odors on wastes, was surprised to learn that half that amount would go a long way toward paying for research that might permanently solve this particular waste problem.

Action by the Board

A three-point policy on labor legislation, approved by the Board of Direction, is as follows: (1) professional employees should be guaranteed the right to their own bargaining unit and choice of their own representatives for negotiation; (2) no professional employee should be forced into a bargaining group with non-professional employees or to submit to representation by such a group; (3) no professional employee should be forced to join any labor organization as a condition of his employment or to sacrifice his rights to individual relations with his employer.

The board also urged modification of the Bloom bill (H. R. 4982) and supported proposed legislation to change the name of Boulder Dam back to Hoover Dam. The Board decided to submit to the membership a questionnaire on proposed changes in membership grades to be voted on only after special meetings of local sections. The Engineers Joint Council program for further unification of the engineering profession was voted support.

Boris A. Bakhmeteff was nominated as representative of the Society on the board of the Engineering Foundation; V. T. Boughton, associate editor, *Engineering News-Record*, was appointed ASCE representative on the Engineers' Council for Professional Development, succeeding R. E. Bakenhus; and the field covered by the A. M. Wellington prize was extended to include papers on foundations and closely related subjects. Recommended rates of pay for different grades of engineers were advanced from 22 to 41 percent over 1944 figures.

Autobahn destruction criticized

That our highways and bridges designed for everyday commercial use will carry military traffic adequately was the conclusion reached in the paper prepared by John W. Wheeler, executive assistant to the president, C.B.&Q. Ry., Chicago, read by William N. Carey. The paper commented on the uselessness of the complete destruction of grade separations and bridges on the German autobahn system by the retreating German army. It was thought that destruction of single spans would have sufficiently delayed the enemy and would have lessened future reconstruction greatly.

Chas. M. Upham, engineer-director American Roadbuilders Association, Washington, D. C., stressed the part which construction plays in our national economy and said that highway construction since 1933 had lagged greatly behind gasoline consumption and auto registration. He estimated 16 to 20 billion dollars will be required in the U. S. for roads and highways during the next 10 or 12 years.

Suspension bridge studies

The new Tacoma Narrows Bridge, said C. E. Andrew, chairman, consulting board, Washington Toll Bridge Authority, will be "eminently safe". Designs call for a four-lane structure with cables 60 ft. apart which make use of the old anchor piers, designed for closer-spaced cables, by placing around each one, in horse-shoe shape, an additional 10,000 cu. yd. of concrete. Double lateral systems and mechanical damping devices will be in the new design chiefly for insurance purposes as it is planned for stability without them.

Wind tunnel experiments, said F. B. Farquharson, professor of Civil Engineering, University of Washington, have as yet only scratched the surface on new theories; data must be collected on many suspension bridges to develop aerodynamically safe design. Models of wind tunnel sections of the Golden Gate bridge are being tested to interpret movements recorded on that structure. It is unfortunate that no information has been published on vertical movement of the Deer Island Bridge, he said, which are reported to have been in the neighborhood of 25 ft., a terrific movement for such a structure.

Material shortages block Tulsa, Okla., construction

A $7,000,000 post-war improvement program of Tulsa, Okla., which had been expected to be well under way by summer, is still delayed by shortages and other current difficulties. As a result, city officials now say that most of the proposed projects may have to be postponed to 1947 before actual work can be started.

Although scarcity of critical materials—such as steel, lumber, and equipment is seriously hindering the city's program, work has started on a number of smaller projects where requirements for completion do not call for quantities of such materials.

Tulsa County is also experiencing delays. The county commissioners on July 8 rejected all three bids submitted on a projected half-million dollar bridge across the Arkansas River on U. S. highway No. 169 near Jenks.

ASCE seeks Wagner Act clarification on rights of professional employees

Society contends present law, placing professional and non professional employees in same group, "not in public interest"

Clarification of the Wagner Act to protect the rights of professional employees is called for in a statement by the American Society of Civil Engineers placed before a subcommittee of the Committee on Labor of the House of Representatives on July 10.

The ASCE statement, which is signed by William N. Carey, secretary and executive officer, and E. Lawrence Chandler, Washington representative, declares that the fundamental difficulty with the present labor law as it affects professional employees is that it places professional employees and non-professional employees within one incompatible category. "Professional services are predominantly intellectual and are varied in character. Constant demand exists for originality and creative thought in the solution of problems presented with each new undertaking. Technical skill is only a part of the equipment of a professional person. There is no yardstick by which creative ability can be measured.

Different standards of work

"To require the application of the self-same standard of operations for professional men and non-professional men is not in the public interest. The output of professional employees cannot be standardized as can be that of manual and skilled labor."

"We recognize the principle of collective bargaining to be a fundamental right of all employees, professional and non-professional. We deny, however, the right to require any employee to belong to any organization as a condition governing his employment.

Mixed unions inappropriate

"The background, education, training and work interests of professional employees and non-professional employees are poles apart. It is futile to expect that a forced grouping of the professional and non-professional employees in any plant or organization could possibly form an 'appropriate bargaining unit'. Under present law and its administration, such plainly inappropriate groupings are made and, by fiat, are declared appropriate. We do not consider this to have been the intent of Congress. We believe that the law should be made so clear and explicit with regard to this matter as to eliminate the possibility of such grouping."

"Consideration by your committee is directed to three specific points which we believe are of fundamental importance for inclusion in any legislation which establishes standards for collective bargaining between employers and employees, namely:

(1) Any group of professional employees, having a community of interest and who wish to bargain collectively, should be guaranteed the right to form and administer their own bargaining unit and be permitted free choice of their representatives to negotiate with their employer.

(2) No professional employee, or group of employees, desiring to undertake collective bargaining with an employer, should be forced to affiliate with or become members of, any bargaining group which includes non-professional employees, or to submit to representation by such a group or its designated agents.

(3) No professional employee should be forced, against his desires, to join any labor organization as a condition of his employment or to sacrifice his right to individual, personal relations with his employer in matters of employment conditions."

Definition of professionals

The statement goes on to say that defining a professional employee is not an easy task but that an appropriate designation is not at all impossible. As a practical and workable definition, the ASCE proposes that state registration in a profession be accepted as prima facie evidence of professional status.

It is proposed further that the labor status should carry a provision to the effect that no person licensed or otherwise legally authorized by any state to practice any profession shall be obligated, as a condition to his employment in the practice of his profession, to join any bargaining group, nor should he be forced to accept representation by any bargaining group.

FPC approves $39 million pipeline construction work

The Federal Power Commission, in a series of recent actions, approved the construction of fuel pipelines that will cost about $39,000,000. Among the projects approved are:

Tennessee Gas and Transmission Co., Houston, Tex., to increase by 118,000,000 cfd. the capacity of its 1265-mile main pipeline system from Driscoll, Tex., to Cornwell, W. Va., at an estimated cost of $27,405,717.

United Gas Pipe Line Co., Shreveport, La., to construct additions in Mississippi and Louisiana at an estimated cost of $2,777,000.

Cincinnati Gas Transportation Co., Charleston, W. Va., to construct approximately 70 miles of 14-in. natural gas pipeline from Foster, Ky., to Means, Ky. Cost of this line is estimated at $1,800,000.

The East Ohio Gas Co., Cleveland, Ohio, to construct and operate a 144-mile pipeline from the Ohio-West Va. state line to the outskirts of Cleveland, at an estimated cost of $4,620,000.

Southern Natural Gas Co., Birmingham, Ala., for various work in Alabama to cost an estimated $2,608,200.

Kentucky Natural Gas Corp., Owensboro, Ky., to construct about 18 miles of 10¾-inch natural gas transmission pipeline near Russellville, Ky.

Calif. claims $1,000,000 for road flooding

A $1,000,000 claim by the California Highway Department against the federal government for flooding of highways by the Prado flood control dam was recently decided against the state agency by U. S. District Court Judge J. F. T. O'Connor.

The decision, on file at Los Angeles, held that eight miles of highways in San Bernardino and Riverside counties in the retarding basin of the dam which are flooded during high water on the Santa Ana River are county highways, outside of the state's jurisdiction.

The federal government had obtained an eminent domain judgment to permit construction of the dam in which the counties deeded it the right to flood roads in the basin. However, the state maintained that the county highways in question had been taken over by the state when they coincided with routes chosen by the legislature for the state highway system.

The state has asked that the highways be relocated outside the flood area at government expense.

The state's attorney, Frank Durkee, reported that the highway department would appeal the case in circuit court at San Francisco within a few months.

Prado Dam was built by the U. S. Army Engineers and completed during the year 1941.

House group approves $375 million of federal aid for civilian hospitals

Total construction needs, based upon prewar prices, placed at $4 billion by the U. S. Public Health Service

Federal aid for civilian hospital construction by state and local governments in the amount of $75,000,000 yearly for five years—plus an appropriation of $3,000,000 for surveys and planning—has been approved by the House of Representatives Committee on Interstate and Foreign Commerce in reporting out a bill (S. 191) to amend the Public Health Act. This bill, which is an authorization measure only, and contains no money, was passed by the Senate in December (*ENR* Dec. 20, 1945, vol. p. 846). It is probable that the measure will be passed by the House as a whole and forwarded to the White House before Congress recesses late in July.

Under the terms of the measure as passed by the Senate, a state would receive federal funds varying from 25 to 75 percent of the cost of carrying out a civilian hospital project—the amount of aid supplied being greater for those states with a lower per capita income. The House committee changed the matching provision so that the federal government will supply a flat 33⅓ percent of the cost of approved programs, the distribution of the money being based upon a rather complicated population formula. Also, the House group favors the use of only $3,000,000 for planning, which compares with $5,000,000 for this work as the bill passed the Senate.

During the House hearings on the bill, the U. S. Public Health Service submitted data that placed the health facility needs of the states at nearly $4 billion. A breakdown of these needs is given in the accompanying table. A public health service report on the nation's water supply, sewerage and garbage collection needs was given in *ENR* June 20, 1946, vol. p. 949.

It is to be noted that the table is based upon prewar construction prices. If present prices were employed, the estimated cost per unit for general hospitals would be increased from $6,000 to between $8,000 and $9,000, the Public Health Service estimates. Cost per bed in tuberculosis, mental and chronic hospitals would need to be increased in proportion.

General hospital needs shown in the table are based on an estimated need (including existing facilities) of 4.5 beds per thousand of the 1940 population, the needs for mental hospitals on 5 beds per thousand and chronic hospitals on 2 beds per thousand. Requirements for tuberculosis hospitals are based on the death rate from this disease in three years, 1941, 1942 and 1943. The replacement needs are based on the assumption that 25 percent of existing facilities need to be replaced.

ARBA sees $700 million highway building year

Despite shortages of material, labor, equipment, steel and engineers, highway construction to date totals $400,000,000 and may reach a full-year figure of $715,000,000, Charles M. Upham, engineer-director of the American Road Builders' Association said in a statement at Washington last week.

His figures tallied closely with those of Engineering News Record's Business News Department, which showed a total of $358,000,000 worth of highway construction contracts let during the first six months of 1946. This rate—nearly three times the rate for the corresponding period of 1945—also indicates a $700,000,000 construction year.

OK Vets school building

Before forwarding the deficiency bill, H. R. 6885, to the White House for signature, Congress added $75,000,000 for the Bureau of Community Facilities of the Federal Works Agency for construction of additional facilities, other than housing, at educational institutions furnishing training to veterans.

Before the money actually can become available, either of the bills S. 2085 or H. R. 4952 must be made law. S. 2085 has already been passed by the Senate.

Expansion of priority aid refused Army Engineers

A petition by the U. S. Army Engineers requesting the Civilian Production Administration to amend CPA Directive 41 to permit the corps to use its MM priority rating to obtain critical construction materials for rivers and harbors and flood control work has been refused.

To avoid further diversion of construction materials of any type from the free market, both CPA and the Office of War Mobilization and Reconversion have decided that it is much more advisable to study means of reducing the priorities now in use. Director Small of CPA has suggested that studies should be made to see if the MM rating could not be eliminated entirely.

Despite the decisions of CPA and OWMR, four priority ratings for obtaining building materials in short supply remain in force. These are: AAA, MM, CC, and HH. The first is the sole remaining civilian rating used during the war by the War Production Board, predecessor of CPA—and it takes precedence over all other ratings. This priority is only granted in the most urgent cases.

The MM rating is used solely for military construction under provisions of Directive 41. It can be assigned by the Army and Navy and other military governmental agencies.

The CC rating is assigned by CPA under the terms of priority regulations 28 and 28A. Known as the "bottleneck breaker," this rating is issued for manufacturers and producers to secure equipment or critical material for lack of which production at a minimum economic rate is impossible.

Equal in standing to the CC rating, the HH priority is used in connection with housing primarily for veterans and is granted by the Federal Public Housing Authority under power delegated this agency by the CPA through the National Housing Agency.

NATION'S NON-FEDERAL HEALTH FACILITY NEEDS

Type	Units Needed	Estimated Unit Cost	Total Estimated Cost New	Total Estimated Cost Replacement
General Hospitals				
New beds (deficit)	169,579	$6,000	$1,017,474,000	
Replacement beds	83,889	6,000		$503,334,000
Tuberculosis Hospitals				
New beds (deficit)	65,189	5,000	325,945,000	
Replacement beds	17,313	5,000		86,565,000
Mental Hospitals				
New beds (deficit)	208,963	3,000	626,889,000	
Replacement beds	99,583	3,000		298,749,000
Chronic Hospitals				
New beds (deficit)	270,173	3,000	810,519,000	
Public Health Centers	4,503	60,000	270,180,000	
Total Cost—New (deficit)			$3,051,007,000	
Replacement				$888,648,000
Both				$3,939,655,000

Appoint new engineer for Seattle district

Col. L. H. Hewitt has assumed duties as district engineer for the Seattle District, succeeding Col. Conrad P. Hardy, recently transferred to military construction duties in the European theater.

Col. Hewitt

Colonel Hewitt, the twenty-sixth engineer officer to hold the Seattle assignment, was chief engineer of the Far East Air Forces from 1943 until last December, when he was transferred to Washington to serve on the Beach Erosion Board.

A graduate of West Point in 1918, Colonel Hewitt's military career has included tours as an instructor at West Point; as a member of staff headquarters in the Philippine department; district engineer at Galveston, Texas, and many other military assignments at home and abroad.

More subway garages for California cities

A second underground garage to relieve downtown traffic congestion in San Francisco, Calif., is nearing the construction stage with the letting of bids by the city park commission for a lease to the subsurface space under St. Mary's Square.

Under bid specifications set by the commission, actual building operations on a 3-level, 630-car garage should start within six months.

The Union Square Garage, a 4-floor, 1,700-car structure, the city's first underground garage, was completed in September, 1942. (*ENR*, Oct. 15, 1942, p. 520.) The corporation that built that garage has announced that a new corporation is being formed with the same leadership to bid on the St. Mary's project.

C. H. Wall, president of the Union Square Garage Corp., reported that his group plans to submit a bid to construct the subterranean structure as a civic enterprise, on a nonprofit basis, with the garage reverting to the city as soon as it pays for itself. He said that his group has calculated the cost of the project as slightly less than $1,000,000.

The park commission stipulated that $7,500 must be posted to put the square's surface back in its original condition. The commission has authorized construction on four additional underground garages and will call for bids on these structures in about a month. They are to be built under the Civic Center Plaza, Marshall Square, Huntington Park and Portsmouth Square.

Meanwhile, two other California cities, Sacramento and Fresno, are considering underground parking facilities. A civic group in Sacramento has proposed a $1,000,000, 1,000-car garage under a city plaza. In Fresno, a 5-block, double deck garage costing $2,000,000 has been proposed to city officials.

Construction apprentices steadily increase

Continued expansion of apprenticeship in the construction industry resulted in an increase in the number of apprentices in the building trades of 13.5 percent during June over the total number previously employed, it has been announced by the Apprentice-Training Service, U. S. Department of Labor.

At the end of June, according to incomplete reports, ATS had record of 49,092 apprentices in the various crafts in the construction industry. The reports on these apprentices came from 1941 local groups in all the building trades.

"This increase in the number of building trades apprentices is significant and should soon bolster the skilled worker force needed for home and other essential construction, as an apprentice is a worker from the day he goes on the job and his productivity increases as he gains new skills," William F. Patterson, Director of ATS, declared, adding, "With the nation embarking on a big building program which is expected to extend through ten to twelve years, apprentices being hired now and the journeymen in the building trades have assurance of reasonably continuous employment for years to come."

Public works projects at Seattle approved

The Washington State Development Board has approved Seattle's preliminary request for a $3,429,370 allotment for its postwar public works program, Mayor William F. Devin has announced. Half the allotment will be in the form of an outright grant while the other half must be matched with city funds.

Of the $3,429,370 total, $1,945,000 will go for the Alaskan Way viaduct; $1,000,000 for park, playfield and bathing beach improvements, and $484,370 for an addition to the central library.

Name engineer general as air quartermaster

Brig. Gen. Howard L. Peckham, 49, wartime chief of the Fuels and Lubricants Division in the Office of the Quartermaster General, has been appointed Air Quartermaster on the staff of the Commanding General of the Army Air Forces.

Gen. Peckham

General Peckham succeeds Col. Wilbur Reece McReynolds, who has recently been assigned to the staff of General George C. Marshall at Shanghai, China.

A native of Norwich, Conn., General Peckham graduated from the U. S. Military Academy at West Point with a commission in the Corps of Engineers. His engineering assignments included service in the Office of the Chief of Engineers in Washington; topographical surveys in the Philippine Islands; and military assistant in charge of river and harbor work and road construction in Porto Rico. In 1935 he became regional engineer for the Works Progress Administration at Atlanta, Ga., and later was assigned as assistant engineer on surveys for a proposed canal across Florida. In July, 1938, he served as director of WPA operations in New York City.

Plan to lower Lake Tahoe to stop Truckee floods

Plans to drain 1.1 ft. of water from California's Lake Tahoe into a proposed reservoir on Prosser Creek as part of a $13,000,000 flood control and water conservation project were revealed by U. S. Army Engineers.

The drainage would stabilize the lake level and thus prevent flood damage on the Truckee River, even the flow of water to Nevada irrigation areas, benefit resort property and set up a potential power capacity of 5,000 kilowatts.

The lake would be drained at its present control point near Tahoe City, and a weir would be installed to prevent the lake's level from falling below 6223.3 ft.

The new reservoir would impound 134,000 ac. ft. of water diverted from the Truckee River, the lake's outlet. The river irrigates 35,000 acres in its basin in Nevada as well as land around Carson Sink and Bernley Bench.

The plans for the project must be passed by Army Engineers and then go to Congress for final approval.

ENGINEERING SCHOOL NEWS

H. S. Janssen acting dean at Idaho—S. R. Wright heads civil engineering at Texas A. & M.—Dean Field retires at Georgia Tech.

Back at the University of Idaho as professor of civil engineering and acting dean of the college of engineering is Allen S. Janssen, on terminal leave from the Navy. He joined the Civil Engineer Corps, USNR, in November, 1942, as a lieutenant and spent 23 months on construction work with the Seabees in the Southwest Pacific. He was then loaned to the Army and sent to Ft. Belvoir, Va., on a joint Army-Navy project—the preparation of a soils manual for military engineering use. Following this he was assigned to the Bureau of Yards and Docks, Navy Department, Washington, becoming head of the research section. At separation his rank was lieutenant commander.

Janssen holds three degrees from the University of Idaho—bachelor of architecture in 1930, bachelor of science in civil engineering in 1933, and a master's degree in the same field in 1937. His appointment as acting dean of engineering is effective August 1. He has been closely associated with J. E. Buchanan, new dean of the college of engineering, Iowa State College (*ENR* July 18, vol. p. 82). Since college days at the University of Idaho, both started on the staff as instructors. Janssen followed Buchanan as testing engineer for the Idaho state bureau of highways in operating the testing laboratory at the university. Although one was in the Army and the other in the Navy, their wartime activities were somewhat parallel, involving the preparation of manuals on military construction in forward areas; actual design and construction in forward areas, with emphasis on airdromes and roads; and research work on similar projects in the two branches in the District of Columbia. Janssen's duties at Fort Belvoir took place in the department which Buchanan had directed a few months before he was assigned to overseas duties in the China-Burma-India theater.

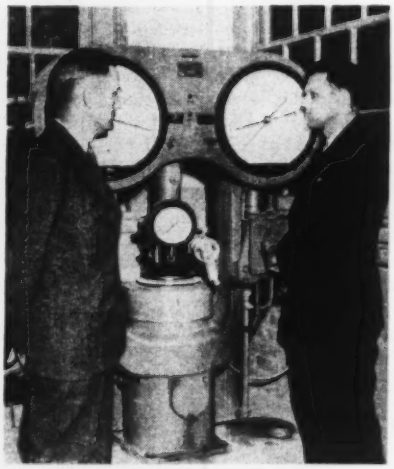
S. R. Wright has been made head of the department of civil engineering of Texas Agricultural and Mechanical College at College Station. Dr. Wright was graduated from Texas A. and M. College in 1924, and has worked for the municipal governments of Waco and Fort Worth.

Prof. Edward L. Moreland has been appointed executive vice-president of the Massachusetts Institute of Technology. He has been dean of engineering since 1938. He will now serve as part-time consultant to President Karl T. Compton and assist in planning new facilities at the institute. A senior member of the engineering firm of Jackson & Moreland, he is well known in the electrical engineering field. He was head of the M.I.T. department of electrical engineering from 1935 until his appointment as dean of engineering.

Prof. James R. Cudworth has assumed his new duties as dean of the college of engineering of the University of Alabama, succeeding Dr. George J. Davis, Jr., who has retired to an emeritus status.

Dean Cudworth has been a member of the faculty 20 years. He took his undergraduate work at Massachusetts Institute of Technology, studied as a graduate student at M.I.T., the University of Alabama and Harvard. He has had engineering and mining experience in the United States and Mexico.

Dean Floyd Field of Georgia Tech has retired after 40 years at the institute. For 28 years he was head of the mathematics department. His record of service is exceeded only by that of Chief Engineer William F. Griffin, who was connected with the school for 56 years.



***Associated for 20 years**—J. E. Buchanan, left, and A. S. Janssen, right, new dean of the engineering division at Iowa State College, and acting dean of the college of engineering at the University of Idaho, respectively, shown together in the laboratory, have been closely associated since college days at Idaho and their wartime activities were somewhat parallel, although Janssen was in the Navy and Buchanan in the Army.*

Charles E. Friley, president of Iowa State College, Ames, Ia., has announced the appointment of Don Stevens, personnel officer of the division of engineering, as operating manager of the College Memorial Union. Succeeding Stevens as personnel officer will be Prof. L. R. Hillyard of the department of general engineering, who received his bachelor's degree at Iowa State in 1932 and his master's degree in 1936 in engineering.

Courses in engineering, prepared by the Quebec Hydro-Electric Commission have been inaugurated at the Polytechnical Institute, Montreal, Que. This is to provide practical knowledge to student employees of the commission. Courses will be in English and French.

The Georgia Tech Research Institute has been organized as successor to the Industrial Development Council. It will implement and coordinate the utilization of Georgia Tech research facilities for industries, associations, government agencies or individuals in search of new or better products, in the development of technical processes, or in the prosecution of fundamental research. It is a non-profit organization with Fuller E. Calloway, Jr., chairman; Blake R. Van Leer, president of Georgia Tech, vice-chairman; Harry L. Baker, Jr., president; Gerald A. Rosselot, director of research and secretary; and Cherry L. Emerson, treasurer.

Thanks to the efforts of Bing Crosby, a gift of $90,000 has been made by General Motors Corp. toward the construction of a $300,000 building for the school of engineering at Gonzaga University, Spokane, Wash. The Rev. Francis E. Corkery, S.J., president of the university, said Crooner Crosby agreed to an option for a second year on broadcasts for General Motors provided the company would donate $90,000 to his alma mater. The company agreed.

The civil engineering seminar in surveying, University of Illinois, opened Monday, July 15, for an eight weeks session in the Chippewa National Forest at Camp Rabideau, near Blackduck, Minn. Expansion of the University of Illinois educational training facilities to the general area of Bemidji, Minn. are provided in a former CCC camp. There are 18 buildings in the camp, including faculty quarters, educational and class buildings, dining hall, student living quarters, recreation building, hospital and service buildings.

OBITUARY

Charles S. Shaughnessy, 69, of Philadelphia, Pa., engineer, died at Asheville, N. C., July 14. He was chief examiner of the Philadelphia, Pa., Civil Service Commission for the last 26 years, and had helped construct New York City's aqueduct water supply system. He was a graduate of the Harvard School of Engineering and taught there for two years before entering the employ of the Pennsylvania Railroad at Altoona, Pa. He later served as engineer in connection with the improvement of the metropolitan park system at Boston, Mass. In 1936, the American Society of Municipal Engineers awarded him a gold medal for long and meritorious service in city government.

Lieut. Col. Sir Heaton Forbes Robinson, 73, civil engineer, died at Victoria, B. C., July 13. Born at Singapore, he was associated with the firm of Sir John Wolfe Barry in general construction and bridge building in South America and Africa.

Charles E. Parry, 68, chief engineer for the Pennsylvania Public Utility Commission, died at Harrisburg, Pa., July 7, two days after the death of his wife. Mr. Parry had been with the commission for the last six years.

Walter J. Armstrong, 60, engineer, died at Montreal, Que., July 1. He was responsible for the construction of many buildings in Canada, including the Royal York Hotel in Toronto and the Mount Royal Hotel and Dominion Square Building in Montreal.

Darwin Rudolph Day, 28, formerly statistician for the Business News department of *Engineering News-Record*, died July 17 at Cuenca, Ecuador, when the commercial airliner of which he was pilot crashed in a landing attempt. Mr. Day, who was graduated from Rutgers University in 1941 with a degree in sanitary engineering, entered the Navy shortly after graduation, and served as a Navy bomber pilot during the entire Pacific campaign, earning two Distinguished Flying Crosses, the Air Medal with three clusters, eight battle stars, a Presidential Unit Citation and other decorations. Released from active duty, he joined the *ENR* staff in October, 1945, but was forced to leave it in April, 1946, for reasons of health. He joined the Latin American Airlines, of Equador, as a pilot, some months ago.

Albert A. Gasteiger, 65, builder and contractor, and member of the common council of the Town of Rye, N. Y., died there July 17.

David M. Bowman, 44, civil engineer with the Washington State Highway Department at Tacoma, died in that city July 10.

James Wingate Sewall, 62, well known forest engineer and consultant, died at Old Towne, Me., July 20. He was a graduate of Bowdoin College, 1906. In 1910 he became a partner of Appleton & Sewall, consulting foresters, and upon the death of Mr. Appleton in 1912 he continued the business under his own name. He had supervised the mapping and evaluation of more than 35,000,000 acres of timberland in the United States, Canada, Newfoundland and Alaska.

James E. Pirie, 65, pioneer Texas highway engineer, died in San Antonio July 17.

Charles M. Scudder, 56, civil engineer for more than 35 years and assistant engineer at A. O. Smith Corp., Milwaukee, Wis., died July 12. He lived in Wauwatosa, Wis., and was principally interested in hydraulics. He received his B. S. in civil engineering from the University of Wisconsin in 1911 and took a further year in post-graduate work in hydraulics. He served as captain in the 107th engineers, 32nd (Red Arrow) division, during World War I.

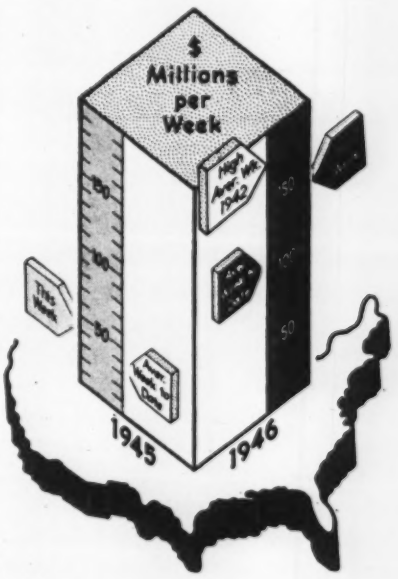
James E. Robinson, 82, former Newark civil and architectural engineer, died July 16 at Point Pleasant Beach, where he had lived for forty years.

Rivers and harbor work under way in Wisconsin

Army Engineers will spend $750,000 for maintenance, care and construction of rivers and harbors projects in Wisconsin during the fiscal year ending June 30, 1947. The work includes:

Duluth-Superior harbor, $140,000; Port Wing harbor, $5,000; Cornucopia harbor, $5,000; Ashland harbor, $22,000; Menominee harbor and river, Michigan and Wisconsin, $45,000; Green Bay harbor, $30,000; Fox River, $22,000; Sturgeon Bay and Lake Michigan ship canal, $80,000; Algoma harbor, $12,000; Kewaunee harbor, $13,000; Two Rivers harbor, $16,000; Manitowoc harbor, $21,000; Sheboygan harbor, $20,000; Port Washington harbor, $10,000; Milwaukee harbor, $22,000; Racine harbor, $21,000; Kenosha harbor, $14,000; St. Croix River, Wisconsin and Minnesota, $22,000; Black River, $2500.

CONSTRUCTION ACTIVITY



As Reported this week to . . .
Engineering News-Record

CONTRACT VOLUME

Continental U. S. Only (Thousands of Dollars)

	Week of July 25 1946	Cumulative 1946 (30 wks.)	Cumulative 1945 (30 wks.)
Federal	$30,932	$473,515	$574,872
State & Mun.	43,220	779,792	173,618
Total Public	$74,152	$1,253,307	$748,490
Total Private	66,705	1,915,473	298,649
U. S. Total	$140,857	$3,168,780	$1,047,139

WHERE CONSTRUCTION ACTIVITY ORIGINATED THIS WEEK

Dollar Volume (Thousands)

Type of Work	This Week	Cumulative 1946 (30 wks.)	Cumulative 1945 (30 wks.)
Waterworks	$2,752	$55,711	$25,112
Sewerage	3,797	58,426	16,896
Bridges	2,475	75,951	19,595
Highways	19,674	449,661	121,639
Earthwork, Waterways	28,567	270,581	23,538
Buildings, Public	9,205	227,376	352,221
Industrial	26,143	596,895	202,208
Commercial	35,230	1,199,919	58,841
Unclassified	13,014	234,260	227,089

NOTE: Minimum size projects included are: Waterworks and waterway projects, $22,500; other public works, $40,000; industrial buildings, $55,000; other buildings, $205,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1946 (30 wks.)	Cumulative 1945 (30 wks.)
NON-FEDERAL	$979,277	$480,375
Corporate Securities	300,968	90,408
State and Municipal	453,309	226,367
RFC Loans	.....	24,600
REA Loans	.....	60,000
Fed. Aid Highway	225,000	79,000
FEDERAL	1,200,052	1,005,325
Total Capital	2,179,329	1,485,700

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	July '46	353.89	170.11
Building Cost	July '46	266.13	143.86
Volume	June '46	344	151

EDITORIALS

VOLUME 137 NUMBER 4

July 25, 1946

One Year of Five

EXPERIMENTS with atomic bombs in the Pacific remind us that the Atomic Age was ushered in a year ago with a blast in New Mexico, followed shortly after by virtual destruction of two Japanese cities. The second year has started with Bikini's bloodless blasts on obsolete ships, the results from which will provide much basic scientific data. In recent issues and in a special section of this issue, McGraw-Hill editors familiar with nuclear fission report the year's advances, the current developments from an eye-witness position at Bikini and the future possibilities of atomic-energy application. These experts estimate that we have not more than a five-year advantage in the atomic-arms race now under way and emphasize that one of these possible five years of grace has expired without effective action toward international control. Recommended as essential reading is this brief, non-technical report of what atomic energy can do for a world at peace and what it undoubtedly will do if another war is allowed to occur.

Sanitary Engineers as Statesmen

RETURNING DELEGATES and official reports from the first Inter-American Regional Conference of Sanitary Engineering held in Brazil last month (*ENR* July 4, vol. p. 4) reveal substantial progress toward the formation of a permanent hemispheric organization. This movement is of more than passing significance when we consider that it was initiated and executed by a group of professional engineers. So often it is said that the engineer subordinates his social, political and economic responsibilities to technological activity. The meeting sponsored in Brazil, however, sought to unite engineers of many countries in a common effort toward making this world a better place in which to live. One means to this end, of course, is the promotion of sanitation. And in the opinion of qualified health authorities it is the sanitary engineer who is best equipped to combat and control the environmental diseases that are the major deterrent to a nation's development and the economic welfare of its people. Technical accomplishments of the sanitary engineer furnish eloquent testimony to his professional abilities; the recent meeting in Brazil and the plans prepared for another in South America this fall reveal his potentialities for development of closer international relations.

For Building Designers

AFTER A LAPSE OF FIVE YEARS, publication of special articles under the title of "Building Designers' Library" has been resumed in this issue with a report on fluorescent lighting. Similar reports will follow on explosion-resistant design, on sound insulation and roofing for industrial plants. This series, inaugurated shortly before the war, has as its objective the presentation of current information on building practice that is not easily available to architects and engineers. The current article on fluorescent lighting is an example. It brings together in convenient form facts about lighting developments during the war years and about types of fluorescent equipment that have not yet gotten into text books.

Culverts vs. Bridges

AN ITEM in the Field and Office section of the July 11 issue concerning culvert construction in South Carolina refers to a practice that is worth more than passing notice. The highway department of that state has been using culverts instead of bridges, wherever feasible, even though first cost may be higher. This is done to provide an unrestricted roadway and to reduce maintenance costs. It represents a departure from the practice widely followed in this country of replacing a bridge with a bridge when replacement is necessary. The latter practice means that restrictions on roadway width that are an inherent part of most bridges are continued indefinitely. On the other hand, if the same stream was to be crossed on a new location, a fresh analysis might well indicate that a large culvert or a group of smaller culverts would provide ample waterway. Improved designs for concrete culverts and much larger sizes for metal culverts have widened the field in which culverts can be used satisfactorily. This fact should be taken into consideration in highway reconstruction work.

More About Culverts

THE foregoing discussion of culverts recalls an incident that occurred when the National Transcontinental Ry. was being built through Northern Ontario in

the early part of this century. There was a rule on that work that designs for bridges had to be made at headquarters, hundreds of miles away, but that culvert designs could be approved in the field. Quite a number of small rivers had to be crossed, and getting designs out of headquarters for the first bridges proved to be such a slow process that construction was delayed. So one of the contractors—who had started out as an engineer—conceived the idea of putting these streams through big arch culverts or pairs of arches with spans up to 20 ft. Arches of such size were unusual in that day and were generally classified as arch bridges. The local engineers agreed to the idea, and some of the big "culverts" were built before top executives discovered what was going on. After the smoke had cleared, new rules were issued further restricting the authority of local engineers with regard to stream crossing. But the net result, in addition to better progress, was that fewer permanent bridges were built and more big culverts were used on the remainder of the line. The moral of this story—if one is needed—is that engineering progress does not always follow the textbook pattern and that it pays sometimes to take the initiative in scrapping tradition or cutting "red-tape."

Overcrowding the Professions

LIMITING the number of students admitted to professional schools frequently is put forward as a means of keeping the professions from being overcrowded. Before the war that proposal was heard frequently in engineering circles; a few weeks ago it was proposed by the head of the Columbia Law School. On superficial consideration many have accepted the idea as having merit, but upon careful examination, it will be found to be contrary to a fundamental American principle of equality of opportunity. Too drastic curtailment of engineering students also might leave the nation more seriously in need of engineers than it was during the war days.

Limiting the number of young men entering engineering schools means that each year a large or small number of men who seek to make a career for themselves in that field may be turned into work for which they have less aptitude. Had such a system of limiting admissions to engineering schools been in effect in the past, some of the great practitioners of today might have been kept out of the engineering field and progress might have been retarded measurably as a result. And if the war taught us anything, it should have shown how quickly an apparent surplus of engineers can be changed into a very real scarcity.

Those who advocate limiting admissions to engineering schools can not logically criticize trade unions for curtailing apprentice training or for refusal to admit new members while some members are out of work. All three plans are alike in that they create artificial scarcity. All are contrary to the principle of equality of opportunity.

In saying this, it is not our purpose to imply that we are in favor of admitting to an engineering school anyone who applies. There should be selection, but it should be on the basis of aptitudes, not on the basis of the number of engineers in active practice at the time the application is made.

All the professions stand to gain considerably through the student selection and guidance work already done, and much more can be accomplished as experience is gained in that work. Tests made in recent years under the auspices of the Carnegie Foundation to determine the academic qualifications of engineering students show much promise. After the results of that research program have been appraised and after methods of application have been perfected, it should be possible to apply these methods in modified form in the secondary schools.

Under such a system, boys having no aptitude for engineering would be turned toward fields in which they will have better chances for success and those with engineering qualifications will be diverted into channels where they and the profession can profit most from the development of latent talent. The difference in numbers between those who begin academic training for engineering and those who successfully follow a career in the profession reveal the importance of careful pre-selection.

If the profession concentrates on the quality of men who take up engineering as a career, it will have little to fear from the quantity of engineers who may be practicing at any one time. Abler men in engineering work, almost automatically, will expand the opportunities for engineers by discovering more and more tasks to which engineering principles can be applied.

ENGINEERING NEWS-RECORD
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BEHIND A CURTAIN OF WAR SECRECY

Construction Speeded Output of "RDX"

***Contents in Brief**—Holston Ordnance Works, not started until June, 1942, produced nearly all of the RDX and Composition B explosive used in winning the U-Boat "Battle of the Atlantic" and in arming the blockbuster bombs that stopped Germany's production. Nor was Holston's product unknown in the Pacific. Built in 22 months, the $107,000,000 plant was featured by multi-story concrete and brick buildings and an unusual water supply system to provide 447 mgd. for cooling, process and domestic use.*

WITHIN a short period in 1942-1943 the Holston Ordnance Works at Kingsport, in northeastern Tennessee, became one of the largest high explosives manufacturing plants in the world. Next to the atomic bomb plant it was also the most famous, but until recently it has been on the secret list. Originally designed to produce 170 tons daily of the superexplosive "RDX," the capacity was "doubled" in theory, but actually averaged 383 tons of RDX daily or 700 tons of "Composition B," a combination of RDX with TNT that was the most powerful explosive known until the perfection of the atomic bomb.

Construction of the ordnance works was completed to a point where it was producing the full design capacity in 13 months and additional facilities to more than double the originally planned capacity were put in operation in another five months. Maximum peak employment reached 18,000 with 39,000,000 man-hours worked. A total of 242 permanent buildings was erected exclusive of 141 magazines for storage of explosives.

About 31 miles of railroad, 59 miles of road, 74 miles of water line, and 37 miles of sewers were installed, some 8,000,000 cu. yd. of rock and earth were moved and 247,000 cu. yd. of concrete placed. Steam capacity installed at the plant totaled nearly 2,000,000 lb. per hr. conveyed by 131 miles of outside steam and process line, while electrical capacity installed was 32,000 kva. The buildings had a floor area of 2,558,000 sq. ft. and a volume of 42,000,000 cu. ft. Overall gross cost of the plant was $107,432,000.

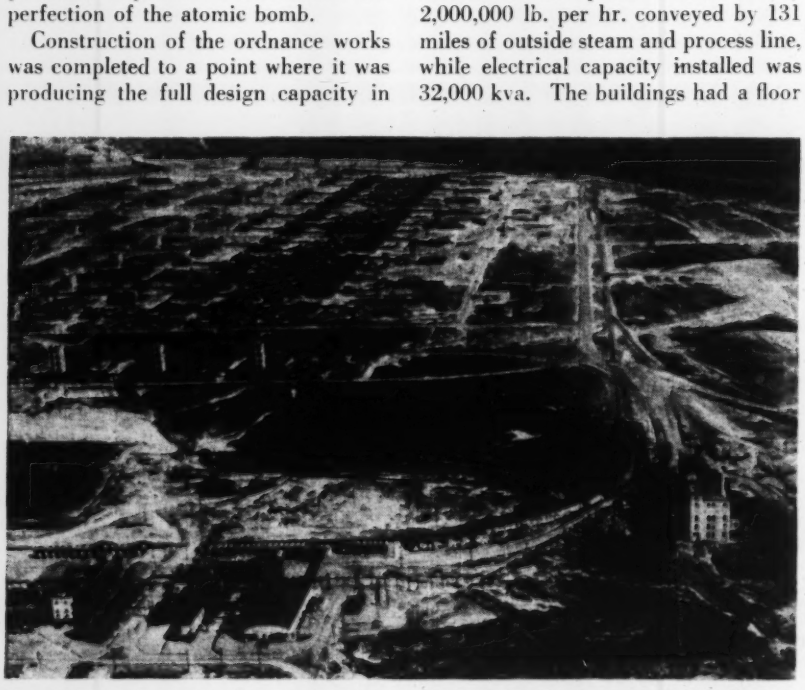

Fig. 1. Plant B of the Holston Ordnance Works. At the upper left are the ten production lines that turned out 434,000 tons of high explosives in two years.

RDX is uncontrollable as a chemical; mixed with TNT, however, and known as Composition B, it is safe to handle. It is the explosive credited with stopping the German submarines and winning the "Battle of the Atlantic," and was of great value in all of the Pacific fighting. Composition B was also the explosive used for warheads of the British 6- and 12-ton block-buster bombs that played such havoc with German structures.

No brief and readily understandable means of comparing power of explosives is available. But some idea of the great force of Comp. B may be obtained from the fact that 1/10 lb. of TNT exploded against a 1/4-in. plate merely dishes it while the same charge of Comp. B punches a clean 2¼-in. hole. It is the fastest acting explosive known, and this accounts for its much greater effectiveness compared with other materials when exploded under water, which is incompressible. Some explosives authorities have stated that not only is Comp. B the most powerful explosive known, short of atomic action, but that it is superior to any explosive material that can be manufactured. To date, no commercial application of the material has been made.

A great quantity of Comp. B. was produced and used in winning the war. During the operating life of the Holston Ordnance Works, until Aug. 15, 1945, its total output was 434,000 tons. This production was achieved by use, for the first time, of assembly line production rather than the traditional batch method of manufacture of explosives.

A pilot plant for the development of the RDX process, operated by Tennessee Eastman Corp., demonstrated that assembly line production was practical, and work was started in June, 1942, on expanding the small pilot installation into an industrial plant with

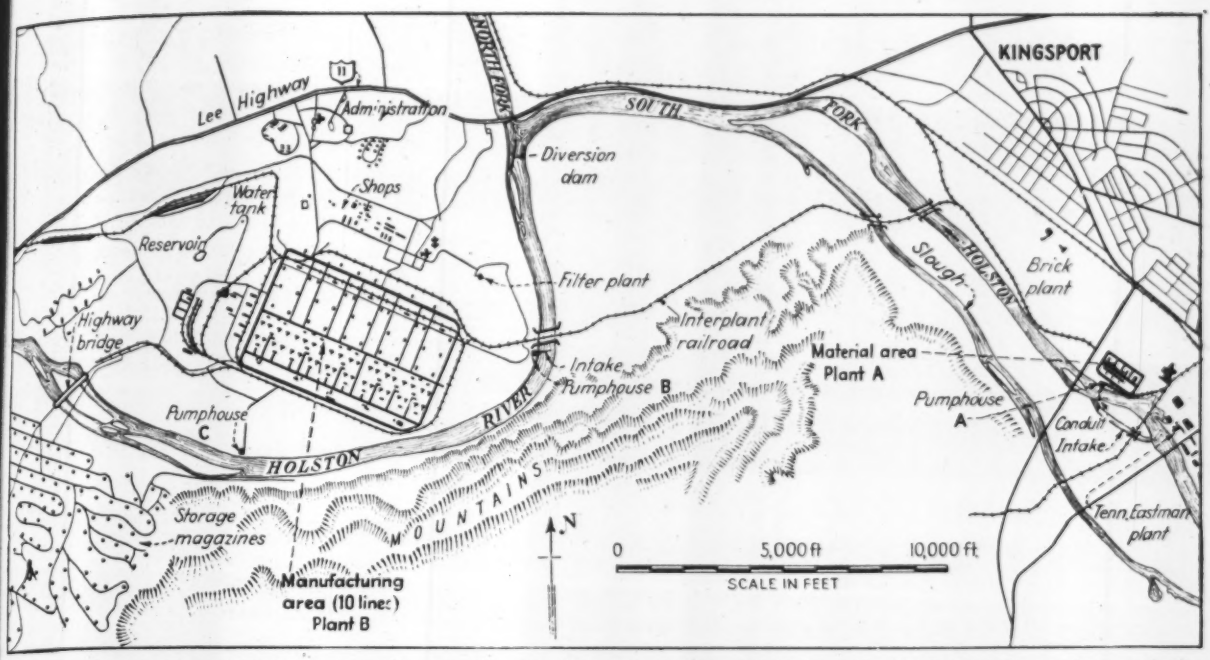

Fig. 2. Holston Ordnance Works is served by 30 miles of railroad from the materials area at Plant A to and around the manufacturing area at Plant B. Three major railroad bridges cross main channels of the Holston River and a highway bridge permits truck access to the storage magazine area.

a capacity 375 times as great. General layout of the plant, design of the manufacturing buildings, design and procurement of manufacturing equipment, and finally operation of the plant was carried out by the Tennessee Eastman Corp. under a fixed-fee contract with the Army Ordnance Department, with Lt. Col. W. E. Ryan as commanding officer on the project.

Direction of the construction work was handled by a specially established Holston District of the Corps of Engineers. All construction and equipment installation, all procurement (other than manufacturing equipment), and all design of temporary utilities and structures were performed by the Fraser-Brace Engineering Co., the architect - engineer - construction - manager for the project under a fixed-fee contract with the Corps of Engineers.

Design of roads, railroads, bridges, utilities, magazines and all buildings other than manufacturing, as well as field layout and field inspection, were performed by Chas. T. Main, architect-engineers, under a fixed-fee subcontract with the Corps of Engineers and Fraser-Brace.

The Holston Ordnance Works consisted of two separate plants, one for raw materials and one for explosives. The function of Plant A was to process and produce materials, principally the preparation of glacial acetic acid and acetic anhydride for use later in the manufacturing process. This plant has seven major buildings of reinforced-concrete frame and brick walls from two to eight stories high.

Manufacture of the explosive RDX was done at Plant B followed by its conversion, by combination with TNT, into Composition B explosive. At this plant there were ten production lines, each line having three large concrete-frame buildings and six wood-frame buildings in the direct manufacturing process, together with several accessory buildings serving two or more lines. There was an acid recovery area, consisting of six concrete-frame buildings each 90 ft. high and several other buildings handling waste and by-products. Also, there were two complete nitric acid manufacturing areas and all of the usual facilities necessary for major plant operation.

Manufacturing process

Each of the ten production lines operated under a continuous process, with raw materials fed into the head of each line and the finished product packed and shipped from the foot.

An integral part of this pioneer continuous process was the retention of raw materials in semi-fluid form throughout the course of RDX manufacture. This permitted piping of the slurry from one step in the process to another, thus eliminating the time and labor-consuming hauling and handling of solid ingredients that had previously characterized explosives manufacture.

A second innovation was the use of the "pellet process" for the fast production, cooling and packing of Comp. B. The powdered RDX was mixed with melted TNT in the incorporation building, and the resulting hot liquid Comp. B explosive passed through specially designed equipment, dropping tiny globules onto a slowly traveling steel belt. These globules, cooling as they traveled, became the solid pellet form in which the explosive was delivered to military units.

The efficiency of these methods and the savings to the government are shown by the fact that during each successive period the cost per pound went steadily downward until Comp. B, which was made at a cost of 30⅞ cents a pound in May, 1943, was being turned out for 10¼ cents a pound in August, 1945. (For comparison, TNT costs 6¼ cents a pound today, 17 cents at the start of World War II, and 58 cents at the close of World War 1).

The work of each of the several organizations engaged in planning, de-

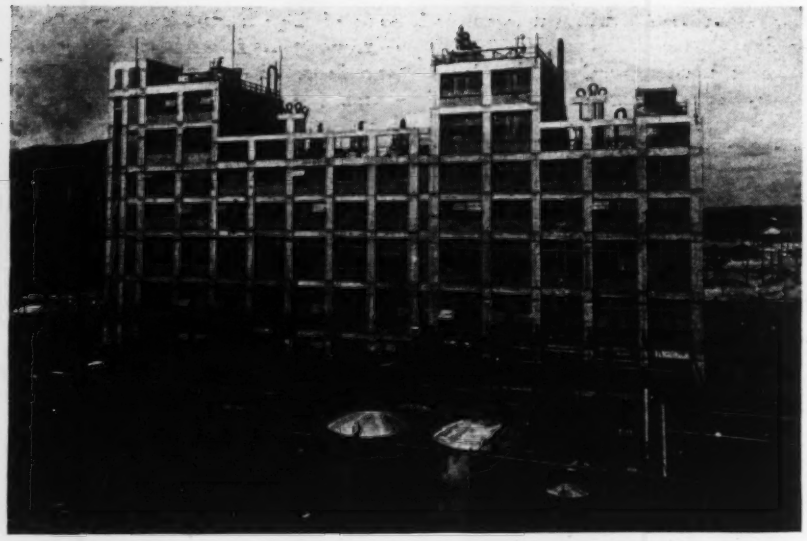

Fig. 3. Typical concrete frame and brick wall building in the Plant A area. Simple frames made possible the frequent reuse of forms, thus speeding construction.

sign and construction of the Holston Ordnance Works is an outstanding story of accomplishment. This article, however, is primarily concerned with the work accomplished in less than two years in building the structures for manufacture. But this, too, is a larger story than can be told briefly. An outline of the contractors organization is followed by a few excerpts from general reports covering all of the work and by an article describing the unusual water system used to provide the half-billion gallons of water per day needed in making powder.

Contractors organization

The Fraser-Brace organization for this construction was set up on broad functional lines with six major departments reporting directly to a project manager, but with each department head possessing full responsibility for the work of his department.

The six major divisions were engineering, procuremcnt, stores, general office, service, and construction. The project manager and his small staff were thus freed of the overwhelming load of detail inherent in this type of project and could concentrate on the coordination of the six departments with each other and with the work of the other agencies.

One assistant project manager was charged solely with administration of subcontracts while another acted as direct assistant to the project manager and was responsible in his absence. An administrative assistant was primarily responsible for screening items so that only major questions requiring attention of the top executives went to the project manager's office.

With the non-productive chores done elsewhere, organization of the construction department was simple and direct. The general works superintendent, with two assistant works superintendents and a small clerical staff, was in responsible charge of all construction and installation of equipment, reporting directly to the project manager. The general works superintendent directed a group of general superintendents who were responsible for the work of assistant superintendents, general foremen, foremen, craftsmen and common labor in their particular fields of authority.

Construction at Holston was divided into two separate projects some five miles apart—Plant A, the raw materials plant, and Plant B, the explosives manufacturing plant. Plant A was treated as a single area, with one general area superintendent in charge; Plant B, considerably larger, was divided into four parts—(1) manufacturing area, utility buildings and bridges (2) recovery area,. acid areas and receiving magazines (3) administration area and (4) shop area and temporary buildings—each headed by a general area superintendent. Each of the five general area superintendents reported directly to the general works superintendent.

In addition to the five administrative areas, nine specialized divisions were organized for particular functions—mechanical, electrical, roads and railroads, water and sewer, painting, cement finishing, bricklaying, heavy equipment maintenance, and concrete. Each of these divisions was headed by a general superintendent reporting directly to the general works superintendent. Each was responsible for its special work in all areas, and assumed the status of a subcontractor to the area superintendent while working in his area.

Truck access of prime importance

From its inception to a point well past the peak construction period, Holston Ordnance Works was primarily a trucking job. Railroad access to both plants was long deferred by the necessity for highway overpass and bridge construction, and every ton of materials received on the project for months had to be unloaded at temporary sidings and trucked to warehouses or construction areas.

Good roads and adequate drainage were the key to progress and the prime construction problem that had to be solved for speed to be maintained. During the 22-month construction period, some 1,200,000 tons of crushed rock was used on the project, the most of it for base and maintenance material for the miles of temporary and permanent roads, parking lots, storage yards, and the like, with additional material for concrete aggregate and for ballast for 30 miles of railroad.

Roads had to be of a type that permitted rapid construction, heavy enough to provide access to all parts of the project for construction equipment such as cleated tractors and tractor-trucks, and after the construction period had to have a surface suitable to carry operating traffic without excessive maintenance.

Chloride and stone on roads

The type of road that seemed best fitted to meet all requirements was traffic-bound crushed-stone base of limestone rock with calcium chloride for dust control, applied as required during the construction period. Application of permanent surface courses of asphaltic concrete, cold tar prime, single or double surface treatment, was deferred until after the major construction was completed.

Permanent design for primary and secondary roads called for a base 22 ft. wide and 8 to 6 in. thick with 7 percent maximum grade. Actually, many roads were wider, and nearly all of them in use during the early stages of construction had much deeper rock surfacing to carry loads in the extremely wet weather of the first year.

Bridges from salvage

Ultimately, railroads were built to serve both Plant A and Plant B and to provide for movement of materials by rail between the two plants, requiring about 30 miles of track. Some 1,400 lin. ft. of steel bridge was required for crossing of major channels of the Holston River plus 3,000 ft. of trestle work over flood plain areas. Truck access from the final assembly area, to the storage magazine section on the opposite side of the river also required a steel bridge highway crossing. In addition, three railroad overpasses required steel members.

Steel for all these structures was obtained either through utilization of abandoned bridge spans found at widely separated locations or by transfer and job fabrication of other secondhand steel.

Two unused bridges on the Southern Railroad near Lynchburg, Va., were purchased "as is, where is" and the Bethlehem Steel Co. was given a subcontract for removal and rebuilding of the structures on the plant railroad. For a detailed description of this bridge utilization see *ENR* June 17, 1943, vol. p. 901.

Concrete mixing and placing

The basic theory underlying the system of concrete production and distribution was that the two central batching plants, in design, layout and erection as well as management and operation, were to be run like commercial plants, the "customers" in the various areas being required to be ready for concrete at a scheduled time. If they were not ready, concrete was rerouted to other users and the delayed pours were rescheduled.

Average demand for concrete was 1,000 cu. yd. a day over a period of several months with possible peak demands up to 3,000 cu. yd. per day. While a few pours ranged up to 1,000 cu. yd. the larger portion of the total was made up of innumerable small pours from ½ cu. yd. up, sometimes at as many as 40 different locations per day.

Conventional central batch plants were set up at Plant A and Plant B; these were fed by cranes, batching to 57 transit-mix trucks. One of the concrete plant's largest customers was the subcontractor for the construction of 130 beehive type storage magazines, which required 14,000 cu. yd. of concrete, sold delivered at a price of $8.50 per cu. yd.

Brick used extensively

A reinforced-concrete frame and brick wall design was adopted for most of the heavy manufacturing buildings and for the steam plants, primarily to save steel. Several of these buildings might have been built of all concrete, but lumber was exceedingly scarce and brick was used to save not only steel but form lumber.

Brick was available in ample quantities for immediate delivery from a plant at nearby Kingsport. An adequate number of capable bricklayers also was available, making cost of brick construction not excessive as compared to frame construction. Consequently, many buildings that normally would have been of frame construction were built of brick, including the permanent administration buildings and the staff residences.

Manufacturing buildings generally were of the spandrel-frame type with columns at 20 ft. or less spacing and with floors of simple beam and slab-design. Exterior walls were supported on the frame at each floor level. In accord with usual explosive plant practice some wall areas were of wood, designed to blow out rather than confine and intensify an explosion.

Concrete delivered by the transit-mix trucks was raised by tower hoists and distributed by concrete buggies. Columns were carried up only one lift ahead of the floor concrete. Forming of the columns was done with reusable panels so far as size uniformity permitted. Floors were of ordinary concrete supported during construction by wood shores.

To expedite enclosure, brickwork was started right behind the concrete. As pipe scaffolding was not available it was necessary to build wood scaffolds to the top of the building.

Some $535,000,000 worth of process equipment was installed in these plants under other contracts, of which half was put in during a three months period in the spring of 1943. Wells through the tall buildings permitted hoisting the equipment to the desired floors. In some cases a panel of the walls was left out and machines set in on the floor by long-boom cranes working from the ground.

Fifty-two firms were directly en-

Fig. 4. The interplant railroad required three large steel bridges. All were provided by salvaging old bridges from existing or abandoned railways.

gaged in construction at the site and thousands of companies throughout the country supplied materials and services for the project.

For Fraser-Brace, J. H. Brace, vice-president, and Alexander Allaire, general manager, furnished general supervision. All construction and management was directed by Harry Englander as project manager, assisted by L. Z. Dolan and C. L. Jacob, the latter in charge of subcontracts. L. D. Brown was construction engineer, and T. T. Cortelyou was general works superintendent.

Frank M. Gunby served as director of engineering for Chas. T. Main, Inc., assisted by George H. Carr and Truman Safford.

For the Corps of Engineers, Lt. Col. E. R. Gates, Lt. Col. R. W. Castle, Lt. Col. W. A. Davis and Col. Reading Wilkinson successively were district engineers of the Holston District, serving under Col. C. L. Hall, division engineer of the Ohio River Division. Valuable assistance in the initial organization and direction of the project was received from Major General L. R. Groves, and from Frank Creedon and W. E. O'Brien, civilian heads of the Construction Branch, Office of the Chief of Engineers in Washington, D. C.

WATER FOR THE HOLSTON ORDNANCE PLANT

An industrial water supply of unprecedented magnitude was required for the explosive manufacturing plant described in the foregoing. Its magnitude may be judged by the fact its capacity ultimately was stepped up to 447,000,000 gal. per day, or nearly the capacity of the proposed new system for the whole city of Philadelphia.

The only source for such a quantity of water was the Holston River, but that source was far from ideal due to waste discharges from the Tennessee Eastman Corp. plant upstream from Plant A, the materials processing plant. Also, the North Fork of the Holston, which joins the South Fork just above Plant B, had objectionable mineral constituents.

Plant A water supply

As the two plants are five miles apart (Fig. 2), separate water-supply facilities were planned for each.

Plant A required five separate water distribution systems—high-head raw water, low-head raw water, filtered water, fire protection and drinking water. Drinking water was obtained by tapping the Kingsport municipal supply, while river water supplied the other four systems.

To secure water uncontaminated by industrial waste and 15 to 20 deg. cooler than that passing the Plant A site, an intake was located 2,000 ft. upstream and on the opposite side of the river from the Tennessee Eastman plant discharge. A rock-fill bar was constructed in the river just above the TEC discharge, using 3,250 tons of rock, to divert the water into the intake canal, Fig. 5. To prevent wash, part of the canal slopes was surfaced with riprap, made of precast concrete.

Conduit under the river

Placing the intake canal on the side of the river opposite the plant introduced the problem of transporting a large quantity of water across the river to the pumping plant. This was accomplished by building a conduit 500 ft. long under the river to the pumping station. This was done in open cut, the river being diverted to alternate sides by cofferdams to permit construction of the conduit in two sections.

Since excavation for the steam plant and pumphouse was in progress while conduit construction was going on, the spoil from these sites was used for the cofferdams, rock being placed on the slopes to prevent scour. The conduit was all in rock, its sides and bottom being lined with reinforced concrete. The top was made of precast concrete slabs set flush with the river bottom. The slabs were accurately cast and set close together, but it was not considered necessary to make the top watertight.

Pumphouse A, at the plant end of the conduit, is a reinforced concrete structure 63x152 ft. in plan. Pumps having a total capacity of 180 mgd. were installed in this structure.

A water treatment plant with a capacity of 6 mgd. supplied the filtered water required for Plant A. Treatment provided included chemical flocculation, and primary and secondary settling with rapid sand filtration.

Fire protection was furnished by a high-pressure system with stand-by pressure of about 110 psi., maintained by a cross-connection to the fire protection system of the existing TEC plant.

Pipe tunnels, 9x12 ft. in size, were used in the congested area around the buildings. They carried 48-in. high-pressure, 30-in. low-pressure and 4-in. drinking-water pipelines together with other utilities. These pipe tunnels were more than a construction expedient in that they offered distinct advantages in accessibility for later maintenance and changes in water lines.

The explosive manufacturing area, Plant B, has an entirely separate water system. A logical site for the water intake was at a point a short distance below the confluence of the North and South forks of the Holston River, the plant being situated on the North Fork side of the river at that point. In that part of the river channel, islands tend to separate the flow of the objectionable North Fork water from the South Fork. To augment this separation, rock-fill barrier dams were constructed in the channel. They were carried up to a level only 2 ft. above low water, as at high water, with dilution from surface runoff, the North Fork water was usable.

The intake for Pumphouse B was located in the river about 500 ft. offshore to secure water from the South Fork flow only. A submarine conduit similar in design and construction to that at Plant A, connected the intake to the pumphouse. The total pumping capacity was about the same as at Plant A.

Additional pump capacity

When an increase in plant facilities to double the production capacity of the project was ordered, an additional pumphouse, C, was constructed on the north bank of the Holston about two miles downstream from Pumphouse B. Water from this latter station was required for cooling only, and pumps to handle 88 mgd. were installed to take normal flow from the Holston.

Most of the large demand at Plant B was for raw water. Of a total of 267 mgd., only 13 mgd. was run through the filter plant, where it received alum, activated carbon and lime treatment.

Water distribution and storage at Plant B included three separate sys-

tems—raw water, filtered water and drinking water. River water supplied for the first two wells and later the Kingsport municipal supply were the sources for drinking water. About 68 mi. of pipe were installed, including 14 mi. of concrete, cast iron, steel and wood stave pipe from 20- to 60-in. dia., with the balance for smaller lines being mostly asbestos-cement and black steel.

Kind and size of pipe and fittings available often influenced the distribution system design. The last water line built on the job—a drinking-water connection from Kingsport to Plant B—was designed to utilize five different sizes and types of pipe in stock on the job so that new pipe would not have to be procured.

Emergency storage facilities

Stand-by raw-water storage, primarily to carry the load long enough for operators to shut down hazardous processes, but also for its stabilizing effect in controlling surges, was provided by a 9-mg. earth reservoir, constructed to ride the raw-water system. This reservoir was built on a narrow ridge in a hard impervious clay that tests showed to be satisfactory for an unlined reservoir. The inlet and outlet system was connected to Pumphouse B by a 36-in. steel line, and to a booster pumphouse by a 54-in. cast iron line. Reservoir level was controlled by an electric liquid-level telemeter.

For fire protection, for stabilization of pressure and for storage of filtered water, a 1-mg. equalizing reservoir rode the filtered water system at an elevation 140 to 160 ft. above the average elevation of the buildings it served. This was a reinforced concrete structure of 100-ft. dia. and 22-ft. depth with a wood roof.

Drinking water a problem

Maintaining a drinking water supply for the Plant B area was a continuing problem. Although three sources were apparently available, none was entirely satisfactory. The municipal supply at Kingsport, the natural first choice and eventually the solution, could not be tapped at the start because the existing filter capacity could not handle the 200,000 gpd. demand in addition to other commitments. Nor did it appear either necessary or economical to produce potable water in the filters at the Holston Ordnance plant because of the quantities required for manufacturing processes.

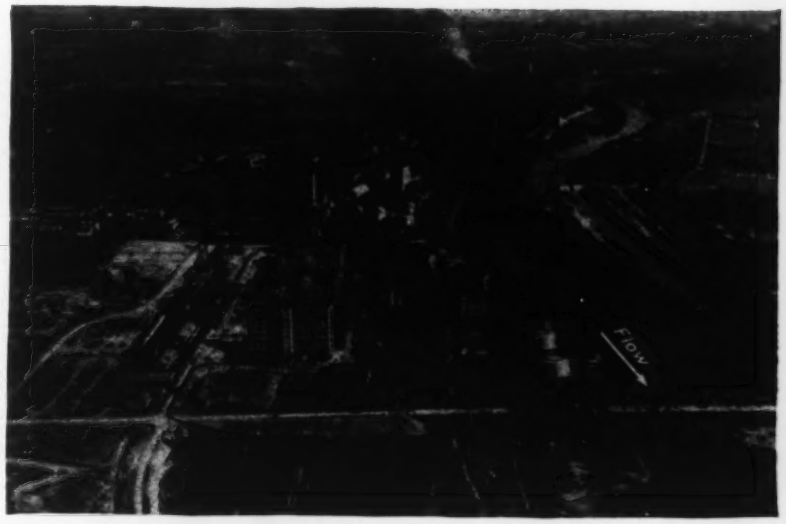

Fig. 5. Water for Plant A was taken from the South Fork of the Holston River above the discharge from the Tennessee Eastman Corp. plant in the background. The intake channel is at the right, with a tunnel under the river near the steam plant. Plant buildings are 7 and 8 stories high.

Thus, wells became the only source for the original plant despite the fact that the area was unfavorable for extensive well development. The yield proved to be uncertain and prevailing soil characteristics made wells subject to pollution from surface water, requiring heavy chlorination and constant testing.

Of the five wells drilled two were abandoned almost immediately because of continual pollution while the remaining three provided a total output of 389,000 gpd. when first placed in service, which was ample for Plant B requirements. After a few months, however, the output had dropped to 200,000 gpd., far below current requirements. Meanwhile, the city of Kingsport was increasing the capacity of its filter plant sufficiently to take care of Plant B requirements.

Construction of the water system for the entire project was one of the most difficult operations to schedule, both for the original plant and for the "200 percent" increase. Basic design requirements often were changed, with resulting delay and revision of construction plans; essential materials—pumps, turbines, motors, treatment plant equipment, pipe and valves—all were hard to get. By the time plans and material were available, construction was thrown into the winter months. More than half of the water lines in Plant B were laid in the months of January, February and March of 1943, when the weather and the shortage of common labor was at its worst. But water was available when needed for explosives manufacture.

Water demand constantly grew

Practically from the beginning of work at Plant B, it had been determined that the production line nearest the steam plant and the acid recovery areas should be the first to go into operation, thus cutting down the amount of steam and process piping which would have to be completed prior to initial operation.

However, the location of the pumphouse and filter plant at the other end of the manufacturing area from the reservoir, steam plant and manufacturing facilities, meant that all of the water mains and a large proportion of the distribution system had to be completed before any part of the manufacturing plant could operate. Pumphouse, filter plant, reservoir and 75 percent of the distribution system were in operation on April 15. From then on, completion of the distribution system as required was comparatively simple. However, the climbing explosive production curve from May of 1943 to the close of construction, with its constantly increasing water demand, created a continual struggle to keep pumping and filter plant capacity up to production demands.

Calyx Drill Aids Soft-Ground Examination

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***Contents in Brief**—By turning with a calyx drill rig, a 42-in. pipe casing was put down through 62 ft. of overburden; the same rig then drilled a 36-in. core into dolomite to investigate foundation material for a lock on the Cross-Florida Barge Canal. Difficulty with turning the casing was overcome by air-jetting, pumping and lubrication with kaolin. Large-size cores and visual inspection of core holes proved the dolomite adequate, despite doubtful indications from conventional small cores.*

AFTER 2½-in. cores from what it was hoped was good bearing strata for a lock foundation showed beds, lenses or pockets of silt in dolomite, a large inspection hole 83 ft. deep proved the reliability of the foundation material at the Dunnellon lock site on the Cross-Florida Barge Canal route.

The canal is planned to extend from the St. Johns River near Palatka across Florida to the Gulf of Mexico near Inglis. Drilling and planning for the proposed work were done by the Jacksonville, Fla., district of the Corps of Engineers, U. S. Army, as part of the preparation for resumption of civil work.

During 1943-44 many exploratory core-borings were taken along the canal route, especially at the dam and lock sites, for the project report and for preparation of contract plans and specifications. At the Dunnellon site there was considerable doubt as to whether silty material found there would be sufficiently confined to preclude piping, which would result in an unstable support for the heavy lock structure.

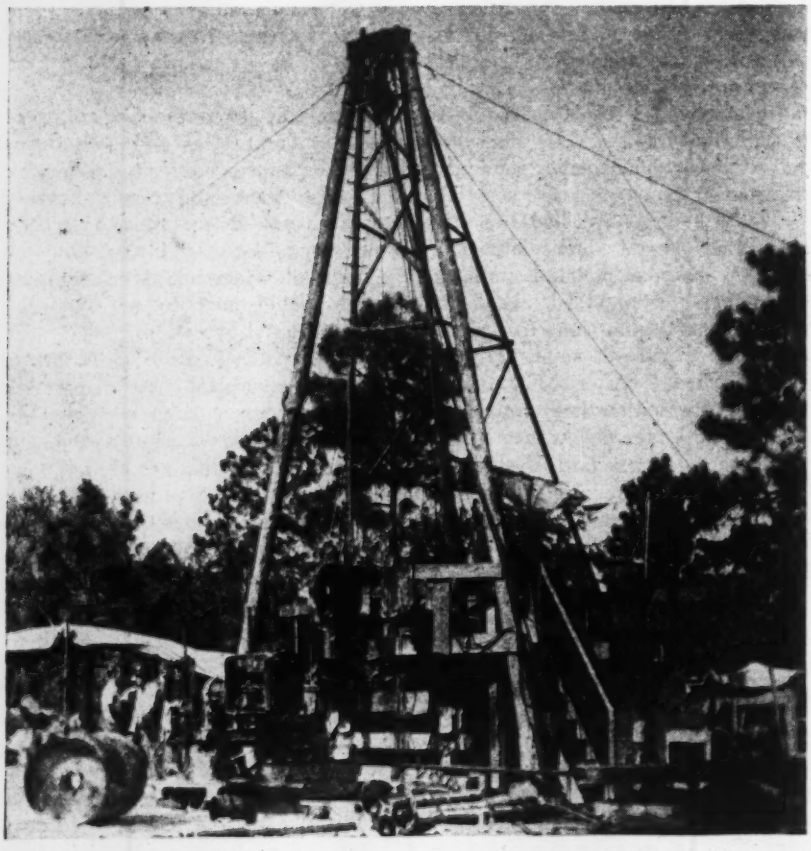

Fig. 1. Reinforced calyx drill rig used to sink 42-in. casing through 62 ft. of overburden and to cut a 36-in. core with a regular calyx bit.

Core borings showed poor rock

The 2½-in. core borings indicated the presence of a medium-hard dolomite formation at foundation elevation. From the cores it appeared that there were soft beds, lenses, or pockets of dolomite silt of unknown lateral extent. Also, there were indications that a part of the silty material might have been produced by disintegration under drill pressure on the soft granular rock, which would, however, afford an adequate foundation in its natural undisturbed condition.

Above the proposed foundation level, which was a few feet below the surface of the dolomite, was 18 ft. of loose, very fine sand over a layer of stiff blue clay overlying 33 ft. of Ocala limestone. The water table was about 5 ft. below the ground surface. There was evidence from the core borings of an abundant flow of water in the Ocala limestone but the dolomite permitted very little flow.

To supplement the small borings, it was decided to drill an observation hole 36 in. in diameter from El. 61 down through the overburden to at

least El. +5, the bottom of the lock foundations.

It was known from previous work that a hole in the Ocala limestone would not stand up without encasement, so a 42-in. steel casing was sunk through the overburden in the limestone to eliminate cave-ins or blowouts and reduce the inflow of water during the drilling operations.

Calyx drill turns caisson

A 36-in. calyx drill rig, powered with a 60-hp. gasoline engine, was used for the drilling and was first utilized to sink the 42-in. dia. casing. The $\frac{3}{8}$-in. thick casing came to the job in 4-ft. sections supplied with $\frac{1}{4}$ x 6-in. collars to facilitate joining the sections and maintaining alignment.

The casing was turned down into the ground by rotating the drill rod, which was fastened to a plate welded to the top of the casing. When the casing had been sunk 4 ft., the turning plate was burned off, a new 4-ft. section of casing put in place and welded both inside and out and the turning plate then welded to the top of the new section. The bottom section of the casing had five $2\frac{1}{2}$x4-in. slots in the cutting edge, virtually making the casing act as a drill bit. Steel shot, up to $\frac{1}{8}$ in. in dia., was fed to the cutting edge through a hole in the rotating plate.

Sinking the caisson

Initially, drilling operations consisted of excavating in the dry ahead of the casing, allowing the casing to sink almost of its own weight. However, the fine, sandy material kept caving into the hole, resulting in a crater around the casing. This made it impossible to drive the casing and would have endangered the drill rig. To prevent caving, the casing was allowed to fill with water and was rotated down ahead of the excavation. Hard material was broken into small pieces with a chopping bit. A 1-cu. ft. orange-peel bucket was used for excavation purposes.

Rotation of the casing became more difficult with the addition of each 4-ft. section. Eventually, the load increased beyond the capacity of the drill rig as the entire length of casing had to be lifted each time before rotation could be started. Loose sand continually drifted in against the casing, tending to "freeze" it, especially when operations were shut down at night or for repair.

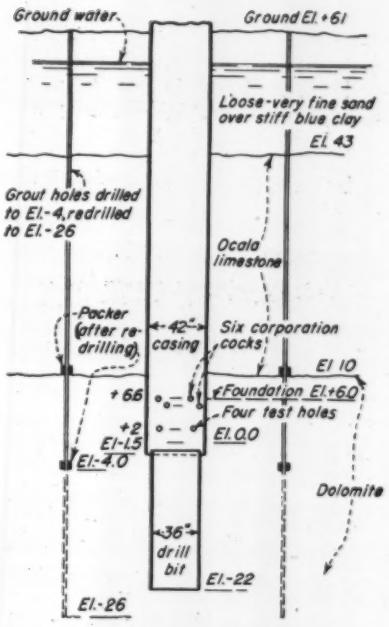

Fig. 2. Six grout pipes drilled at 5 ft. from the casing permitted consolidation of the dolomite so that the core hole was made practically dry.

At a depth of 26 ft. an attempt was made to drive the casing in lieu of turning it, using a 2,200-lb. driving head. This proved ineffective and involved the danger of warping the cutting edge or breaking the joint welds. The driving attempt caused the casing to "freeze" to such an extent that the drill rig was unable to rotate it.

The drill rig was then reinforced and the lifting power increased. A combination of air-jetting, pumping a lubricating mixture of Aquagel and kaolin clay around the outside of the casing, using a long lever to exert a turning moment and lifting with a 4-part cable on the drill rig—all used simultaneously—were finally successful in freeing the casing. The lubricating mixture of Aquagel and kaolin clay was used throughout the rotating operation, which was continued to a depth of 62.5 ft. or El. —1.5.

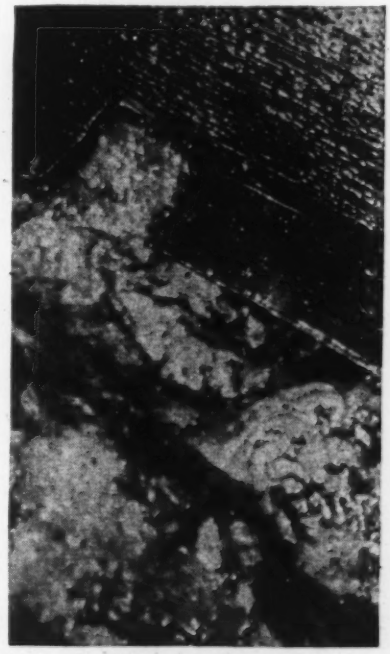

Fig. 3. Bottom of 42-in. casing and the strata exposed by removal of cores below the casing.

Water retarded by grout

Before resuming drilling below El. —1.5 without the protection of the casing, the material between El. +9.8 and —1.5 was grouted to fill in the space between the casing and the rock, thereby preventing an excessive inflow of water that might possibly carry in large quantities of sand. Efforts to drill and drive grout pipes down around the outside of the casing were not successful as the pipes turned in against the casing and caught on the collars at the casing joints.

Grouting was done through holes drilled in the casing at as low a level as water permitted. The inflow of water through the first hole in the casing was so great that it was necessary to use a water-main drill and corporation cocks to prevent flooding. Three $1\frac{1}{4}$-in. corporation cocks were put into the casing at El. 5.6 and three at El. 6.6 for grouting.

The casing was allowed to fill with water during the grouting operation. Upon dewatering the hole several days later, no seepage was observed from four holes drilled through the casing at El. +2.

Upon resumption of drilling, however, inflow of water became 50 gpm. at a draw-down in the casing to El. 37, the maximum draw-down possible with the pumps available at that time.

To eliminate the large inflow of water and danger of the hole caving or blowing-in below the casing, a grout curtain was made between El. +8 and —26. This second grouting was accomplished in two stages through holes equally spaced around and 5 ft. from

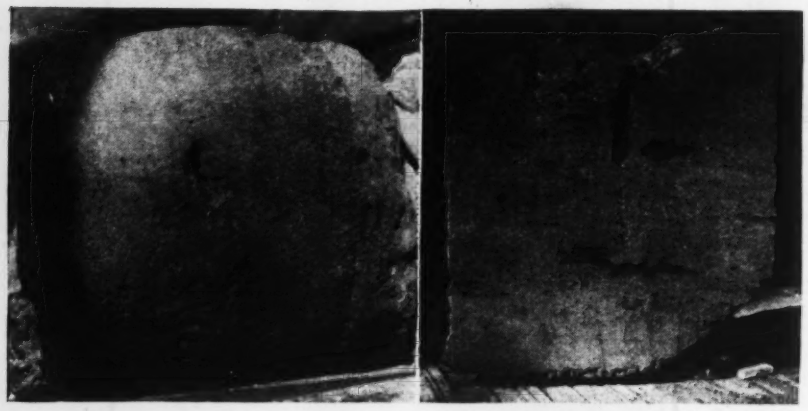

Fig. 4. Large core from the dolomite shows firm material with only scattered pockets, none continuous, of the dolomite silt that in small cores had made the foundation appear of doubtful quality.

the casing. The first stage consisted of grouting through three holes drilled to El. —4 with "packers" to stop upward flow set at El. 10, the top of the dolomite, and at a pressure less than 25 psi. Three additional holes were drilled and grouted between the first three. The second stage consisted of redrilling the grouted holes to 22 ft. below previous drilling, El. —26, and grouting with packers set at El. —4.

Excavation was continued below the casing by rotating the 36-in. bit and breaking the cores with a chopping bit. It was possible to remove intact only one length of 36-in. core (2.8 ft. long and of medium hard dolomite) in reaching El. —22, which was 83 ft. below the ground surface. In other cores, the rock would not hold a pin to permit breaking the cores loose.

The grouting curtain proved effective in reducing the inflow of water. The inflow was 4.7 gpm. at 61 ft. draw-down with the bottom of the hole at El. —5.3; and 14.8 gpm. at 68.5 ft. draw-down with the hole drilled to El. —11.

Foundations proved adequate

Inspection of the material from and in the 36-in. observation hole gave entirely different information than that obtained from the 2½-in. core borings. The dolomite was firm to hard with scattered isolated pockets of dolomite silt, which were of small lateral extent. The pockets did not extend from one side of the 36-in. hole to the other and it was apparent that the thickness of the pockets had been exaggerated, as a result of abrasion, in the small-diameter borings. A few silt pockets measured 0.1 x 0.5 ft. but for the most part, the beds, lenses or pockets measured under 0.1 ft. in dia. and these were surrounded by firm rock. A few thin layers of lignite were encountered at a depth of 70 ft.

Assuming that these conditions are indicative of the general formation of dolomite in the lock site area, it is believed that the foundation rock is satisfactory for the conventional gravity-type lock walls. Undoubtedly, the Ocala limestone will take large quantities of grout whereas the dolomite will take very little.

The test work was done by the Corps of Engineers, Jacksonville District, under the supervision of Col. A. B. Jones, district engineer, and E. F. Tippetts, chief of the engineering division.

Field operations were initiated under Jack E. Harns, engineer in charge of the Ocala resident office, and completed under Fred N. Ricks, who succeeded him. S. C. Happ, geologist of the Ocala resident office, was in charge of inspection and classification of the geologic formations.

New Way to Enforce Building Codes Used in Several Washington Cities

A new money-saving way to insure construction of buildings in conformance with building code standards is being used in several Washington cities, the American Municipal Association reports.

The Washington practice, believed to be unique in the building regulations field, is based on inclusion in building codes of a provision requiring the architect, engineer or contractor in charge to file an affidavit attesting that construction has been completed in compliance with established standards.

The affidavit must be filed before a permit of occupancy may be issued for a new building. If it is discovered at any time that the building was not constructed in compliance with building code standards, the person who signed the affidavit may be charged with a misdemeanor and be subject to fine or imprisonment or both.

The provisions making it one man's responsibility to see that construction is carried out according to approved plans naturally entails direct on-the-job supervision. Structural discrepancies thus may be detected more easily than if a building inspector examined the edifice after it was finished.

Seattle is trying out the affidavit method—in addition to retaining the usual system of building inspection—by allowing the city building department to have plans and specifications checked by private architects and engineers to see that building code requirements are being met. In Seattle, Renton, and elsewhere it is noted that such action is resulting in better plans.

The affidavit system of checking plans and construction was devised especially to eliminate the necessity of small towns maintaining building inspectors on their payrolls at all times. Hiring professional architects and engineers on a job basis not only saves money, but also helps insure against inefficient services of a building inspector inadequately trained.

If the affidavit provision proves successful as a construction control in enough cities, the American Municipal Association observes, municipalities eventually may require contractors to post bond as a guarantee that construction of buildings proceeds as specified. If after construction was completed it could be proved that the building contract had not been fulfilled, the bond would be forfeited.

BUILDING DESIGNERS' LIBRAR

Fluorescent Lighting Developments Increase Lamp Output, Decrease Costs

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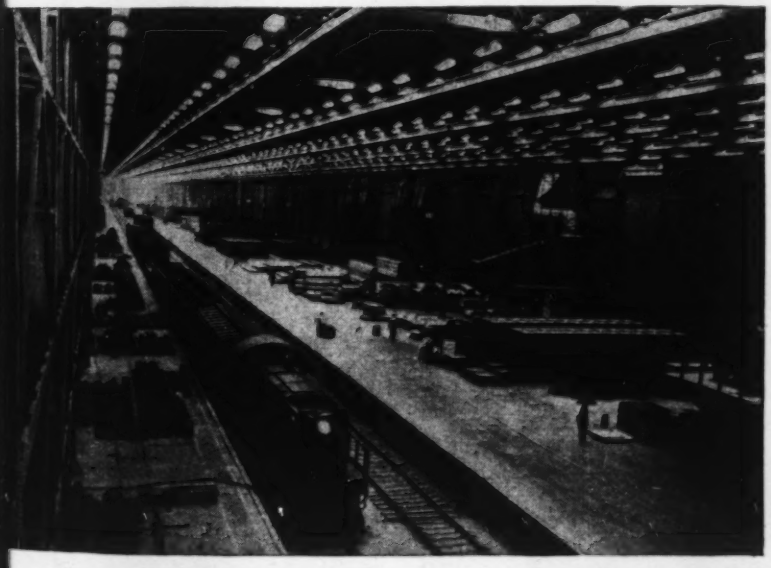
***Contents in Brief**—During the last few years, the development of fluorescent lighting has been rapid, thus making improved lighting equipment available to building designers. The lumen output of most standard fluorescent lamps has been increased, lamp efficiency improved and costs reduced. To the previous group of standard sizes, four miniatures have been added, and in addition, new shapes and colors have been developed.*

MANY DEVELOPMENTS of importance to building designers have occurred in fluorescent lighting in recent years. Chief among them are increases in the lumen output and in the average life of lamps and decreases in the cost of operation. These improvements are certain to foster the trend toward windowless structures and enlarge the field of controlled lighting, which was discussed in the May 16 issue of *Engineering News-Record*, vol. p. 784.

Fluorescent lighting, which was introduced commercially in 1938, has now, after only eight years, emerged into the maturity of a sound lighting system. While basic principles of operation are substantially unchanged from those described five years ago in "Engineering Aspects and Factors of Fluorescent Lighting" (*ENR* May 22, 1941, vol. p. 819), during the last few years different shapes, new colors, improved auxiliary equipment, more efficient fixtures and wider application methods have appeared.

As a result of wartime developments, increases in the lumen output of most standard fluorescent lamps have been made within the last year. For example, in the case of the 40-watt white lamp, these changes represent an increase of more than 11 percent above the ratings in effect about one year ago, whereas the lumen output of the 40-watt soft white lamp has been increased from 1,500 to 1,720 lumens—a 14.7 percent increase.

It is still standard practice to base initial lumen ratings on output of lamps that have been used for 100 hours, although the drop in output of contemporary lamps during the first 100 hours is not so marked as in earlier fluorescent lamps. Significant increases have been made not only in these initial values but also in the maintained values. This means that now a lamp gives more light throughout its life.



Illumination for swift and safe handling of freight is provided by fluorescent lighting in the high-bayed receiving room of Bell Aircraft Corp. plant in Marietta, Ga.

Hours lit affects lamp life

Also, enough data have now been accumulated to evaluate the effect on the average life of a lamp of the number of times it is turned on, and thus, figures are available for rating average life on a 3-hr., 6-hr., and 12-hr. cycle. In establishing these ratings, lamps are allowed to burn for 3, 6 or 12 hours, as the case may be, then are turned off for about 20 minutes and the cycle repeated until the lamp fails.

Taking the 40-watt, standard F-type lamp as an example, the rating on a 3-hr. cycle is 2,500 hr., whereas the life is extended to 4,000 hr. on a 6-hr. cycle and 6,000 hr. on a 12-hr. cycle. For instance, a plant that permits lights to remain on for 12-hr. periods each time they are turned on should receive over twice the average lamp life that would be obtained were they turned off at the end of each 3-hr. period.

The importance of this fact to the designers and owners of large industrial plants is obvious.

Still in great demand are the standard F-type lamps. These employ a cir-

cuit consisting of a ballast to limit the current and a starter to provide a time delay to permit preheating of the electrodes in each end of the lamp before the arc is established. As shown in the accompaning table, F-type lamps are available in 11 different sizes, the most popular being the 40-watt 48-in.

Four sizes of miniature lamps are now included with the standard types and employ the standard fluorescent lamp circuit. The latest addition to this group is the 13-watt, 21-in. T-5 lamp. (The T identifies the bulb as being tubular in shape, while the number immediately following indicates the bulb diameter in eighths of an inch. Thus, T-5 specifies a tubular bulb having a diameter of § in.) These miniature fluorescent lamps are being used in many practical applications as well as in innumerable novelty displays.

Ever since fluorescent lamps first appeared on the market, there has been a demand for lamps of this type in circular shapes. Although the war retarded its development, the first circular lamp, the 12 in., is now available in limited quantity. Future plans include 8½- and 16-in. diameter lamps.

Featuring a translucent base that allows the lamp to be rotated so that it may be mounted in any desired position, circular lamps provide an almost unlimited degree of flexibility in the design and manufacture of portable lamps or ceiling and wall fixtures. The lamps operate on exactly the same principle as the standard fluorescent and require auxiliary equipment consisting of a ballast and a starter.

Decreasing the annoying delay when a lamp is started, recent improvements in starters greatly improve their speed and reliability, while retaining the pre-

ESSENTIAL DATA ON FLUORESCENT LAMPS

	Standard F Lamps										
Approx. Lamp Watts (a)	4	6	8	13	14	15	15	20	30	40	100
Nominal Length—in. (b)	6	9	12	21	15	13	18	24	36	48	60
Bulb	T-5	T-5	T-5	T-5	T-12	T-8	T-12	T-12	T-8	T-12	T-17
Bulb Diameter—in.	5/8	5/8	5/8	5/8	1 1/2	1	1 1/2	1 1/2	1	1 1/2	2-1/8
Base Size (Bipin)	Min.	Min.	Min.	Min.	Med.	Med.	Med.	Med.	Med.	Med.	Mog.
Approx. Lamp. Amp.	0 130	0 160	0.175	0.160	0 375	0.305	0.335	0.355	0.345	0.410	1.45
Approx. Lamp Volts	37	46	59	95	42	56	48	62	103	108	73
Max. Starting Amp.	0.19	0.24	0.27	0.27	0.65	0.65	0.65	0.65	0.65	0.75	2.20
Circuit Voltage Range	110–125	110–125	110–125	110–125	110–125(c)	110–125	110–125	110–125	110–125 199–216 220–250	110–125 199–216 220–250	110–125 199–216 220–250 254–277(d)
Rated Av. Life (e) Cycle 3-hr.	500	1,500	1,500	1,500	2,000	2,500	2,500	2,500	2,500	2,500	3,000
6-hr.						4,000	4,000	4,000	4,000	4,000	4,500
12-hr.						6,000	6,000	6,000	6,000	6,000	6,500
Approx. Initial Lumens:											
White	75	192	320	580	485	585	555	920	1,450	2,320	4,200
Daylight	68	174	290	490	390	525	495	760	1,300	1,880	3,800
Soft White					335	450	420	680	1,170	1,720	3,300
4,500-deg. White						—	—	—	—	2,000	4,000
Blue						315	285	460	780		
Green						900	810	1,300	2,250		
Pink						300	270	440	750		
Gold						375	335	540	930		
Red						45	40	60	120		

	LS (Long Slim) Lamps								K (Cold Cathode) Lamps			Circular Lamps
Nominal Length—in (b)	42		64		72		96		48	72	96	12-in. Diam.
Bulb	T-6		T-6		T-8		T-8		T-8	T-8	T-8	T-10
Bulb Diameter—in.	3/4		3/4		1		1		1	1	1	1 1/4
Base	Single Pin		Single Pin		Single Pin		Single Pin		Single Pin(f)	Single Pin(f)	Single Pin(f)	Rotabase
Starting Voltage	450		600		600		700		500	600	750	150
Approx. Operating Amps.	0 100	0.200	0.100	0.200	0.100	0.200	0.100	0.200	0.120	0.120	0.120	0.425
Approx. Operating Volts	170	150	270	230	245	215	335	290	250	340	420	85
Approx. Lamp Watts (a)	15	25	23	38	22	38	30	32	26	34	42	32
Rated Av. Life (e) Cycle 3-hr.	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500				2,500
6-hr.	—	4,000	—	4,000	—	4,000	—	4,000	10,000	10,000	10,000	4,000
12-hr.	—	6,000	—	6,000	—	6,000	—	6,000	(g)	(g)	(g)	6,000
Approx. Initial Lumens:												
White	900	1,400	1,400	2,150	1,400	2,350	1,950	3,300	900	1,500	2,000	1,600

(a) Wattage of lamps only. Wattage lost in auxiliary equipment must be included to obtain total wattage.
(b) Nominal length includes lamp and two sockets overall dimension.
(c) 14-watt lamps are burned two in series on a 110–125-v. circuit with a single incandescent lamp ballast rated at 0.5 amp., 60 v.
(d) Special sequence starting circuit for four 100-watt lamps.
(e) Average life under specified test conditions.
(f) Single pin base for K lamp has special contour that will not fit in LS lampholders.
(g) Average life independent of cycling.

heating necessary to insure good lamp performance. An improved glow-type starter is also being made available as a cut-out starter to open the circuit automatically when a lamp has failed. This type prevents annoying blinking, resulting from the continued efforts of a burned-out lamp to relight itself, protects the starter from burning itself out and shields the ballast from excessive heating.

The 40-watt instant-start lamp solves the starting problem in another fashion. It has a special shunted base to permit the use of standard sockets wired so that the primary circuit is broken when a lamp is removed. Identical in size and external appearance with the standard 40-watt and having the same lumen output and life, the instant-start lamp uses a special type of ballast to supply, for striking the arc, a sudden, high voltage, which immediately drops to normal. Higher costs for auxiliary equipment and lower overall efficiency due to greater wattage loss in the ballast will probably limit the use of this type of lamp mainly to industries where instant starting is of prime concern.

To facilitate starting under conditions of high humidity, a special hydrophobic material, which is applied over the entire surface of the glass tube of the 40-watt instant-start lamp, has been developed. This is a transparent substance, completely invisible when applied to lamps, that causes a moisture film to resolve itself into many droplets, each separated by a completely dry area.

A recent addition to the fluorescent family is the long slim (LS) lamp. These lamps, made in 42-, 64-, 72- and 96-in. lengths, are similar in operation to the instant-start lamp, but employ a single-contact type of base that requires the use of sockets specifically designed for LS lamps. Because of their length and small diameter, it is expected that they will be readily adaptable to architectural lighting.

Cold-cathode lighting

One of the most promising of the newer lamps, the K type, operates on the same principle as the familiar cold-cathode sign tubing, but is made up in standard lengths on mass-production lamp machinery. Providing instant starting, it has a long rated average life of 10,000 hr., which is independent of the number of times the lamps are started. Though similar in external appearance to the LS, cold-cathode lamps employ a base that is sufficiently different to make it impossible to interchange the two types of lamps in the sockets accidentally.

Circular fluorescent lamps are now available to meet special lighting requirements. Base permits rotation.

Position-indicating nub on side of plastic base simplifies replacement of lamps by providing positive means of determining when a lamp is safely inserted.

Soft white, daylight and other colors will soon be added to the 3,500-deg. white cold-cathode lamps now available. The long-life feature suggests a wide range of industrial and commercial applications where fixtures are comparatively inaccessible and it is difficult to replace lamps.

For the major part of the duration of the war, fluorescent lamps were made only in daylight and white colors, except for special blacklight lamps for military applications. Since early last year, however, manufacturing of other colors has been permitted and fluorescent lamps are now available in a variety of colors.

The daylight lamp, giving a close approximation to natural daylight, has been generally used in certain industrial applications where color discrimination is a factor, whereas the 3,500-deg. white lamp has been widely accepted for most interior lighting applications because of its tendency to intensify the warmer pastel colors, much as the familiar incandescent lamp does. The soft white was developed to produce stronger emphasis on the reds.

Public demand has recently brought forth the 4,500-deg. white fluorescent lamp, which is intermediate in color between the 3,500-deg. white and the daylight lamps. It is available at present in the 40- and 100-watt sizes.

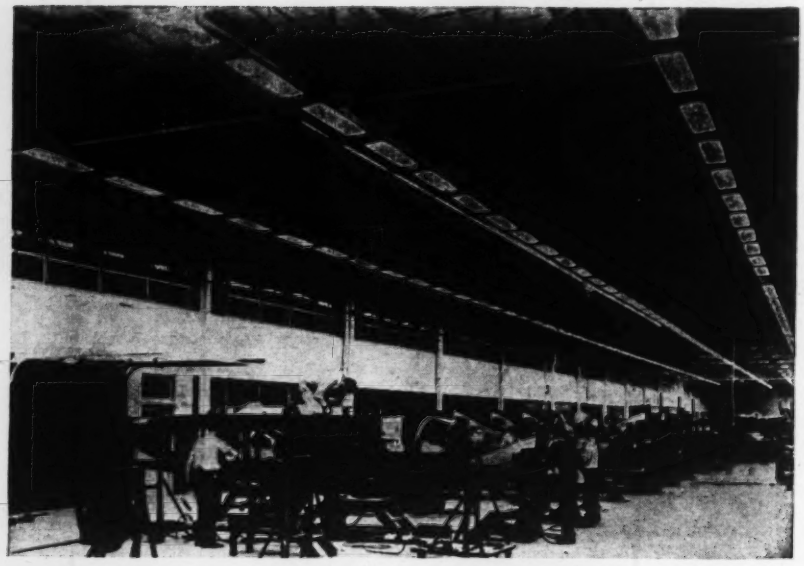
In addition to the above colors, some sizes of lamps are available in blue, green, pink, gold or red. These colors are largely used for decorative purposes.

Blacklight lamps

The war greatly intensified the use of blacklight for aircraft and marine instrument illumination, and these light sources are finding their way into industry in connection with inspection processes. Blacklight lamps operate on standard fluorescent lamp circuits and are available in various sizes from 4- to 40-watt. The maximum amount of radiation produced by blacklight lamps is in the near ultraviolet in the region of 3,600 Angstroms, which wavelength activates the fluorescent pigments in the luminous paints, dyes and lacquers used on objects to be made luminous.

The 360-BL series of blacklight lamps are made with clear bulbs, which transmit considerable visible light as well as near ultraviolet radiations and require light filters for blacklight applications. In the red-purple series, however, the absorption of this visible light is accomplished by the glass bulb of the lamp itself.

Although not a fluorescent lamp, the germicidal lamp is similar in structure and its development has been closely akin to that of the fluorescent lamp. It is available in 8-, 15-, and 30-watt sizes and operates on standard fluorescent auxiliaries. While it has the same physical dimensions as standard fluorescent lamps, it employs clear glass



With the better lighting from fluorescent lamps at the Bell Aircraft Corp plant, production and safety increased, wastage decreased.

bulbs to transmit the 2,537-Angstrom germicidal radiations produced by the arc stream.

These lamps are gaining wide acceptance for killing air-borne bacteria in industrial plants and offices, as well as in hospitals, nurseries, auditoriums and other public places. They are available in two types, which differ only in the transmission characteristics of the glass used—Type A, designed to absorb all ozone-producing radiations, and Type B, which produces a small quantity of ozone.

Other significant developments

Bases for fluorescent lamps have also been improved. Plastic bases, a wartime exigency, have become a boon rather than a necessity. With their deep collars and ribbed construction, they are as strong as metallic bases, besides having a neater, streamlined appearance and an imperviousness to rust and corrosion from plant vapors. In addition, maintenance is simplified by the addition of position-indicating nubs to these plastic bases to provide the tube-replacer with a positive means of knowing when a lamp has been rotated to the proper position in the lampholders.

Noise, one of the primary drawbacks of fluorescent lighting in the early days, virtually has been eliminated from today's fluorescent systems by careful, intelligent engineering. Studios of a broadcasting company, for instance, are lighted entirely by fluorescent lamps, a sure tribute to successful ballast engineering.

Lighting costs reduced

With regard to the cost of lighting, statistics compiled by Bayes Jordon of the Georgian Power Co. show that only 2 percent of the manufacturing industry's capital dollar, or 3 mills out of their operating dollar, go into lighting, while other surveys have shown that proper lighting will step up production 1 to 5 percent, cut down wastage from 5 to 20 percent and eliminate 1 out of 6 industrial accidents—a highly significant figure since industry now spends $150,000,000 annually on account of accidents.

The fluorescent lamp manufacturer is paying bonuses on the lighting dollar by increasing lamp efficiency. In addition, by reducing the cost of lamps, he is giving consumers as much as seven times more light for the fluorescent lamp dollar than was received about seven years ago.

Previous Articles

The Building Designers' Library series includes: "Analyzing Air Conditioning Costs for Blackout Plants." May 8, 1941, vol. p. 751; "Engineering Aspects and Factors of Fluorescent Lighting," May 22, 1941, vol. p. 819; "A New Approach to the Problem of Concrete Wall Reinforcing," June 5, 1941, vol. p. 900; "Cantilever and Combined Footing Designs Compared," June 19, 1941, vol. p. 950; "Lighting Principles and Practice with Glass Block Panels," July 3, 1941, vol. p. 29; "Principles of Ventilation by Wall and Monitor Windows," July 31, 1941, vol. p. 176; "Economics of Air Conditioning," July 17, 1941, vol. p. 112; "Forming Details and Practices for Architectural Concrete," Aug. 14, 1941, vol. p. 240; "How to Prepare Drawings for Structural Welding." Aug. 28, 1941, vol. p. 310; "Heating Industrial Buildings with Direct-Fired Units," Sept. 11, 1941, vol. p. 363; "Pneumatically Placed Concrete for Walls of Industrial Plants," Sept. 25, 1941, vol. p. 435; "Notation System for Indicating Steel in Reinforced Concrete," Oct. 9, 1941, vol. p. 511; "Designing to Save Steel," Nov. 6, 1941, vol. p. 669.

Army Engineers Surveyed Alaskan Railroad in 1942

Disclosure that U. S. Army Engineers surveyed for a railroad in Alaska from Fairbanks to Teller—on the Bering Straits facing Siberia—was made recently at the district office in Seattle. The survey was made in the winter of 1942-43, when it was feared Japan might contest for the Aleutians, and has been kept secret until the recent announcement.

Col. James Truitt, who conducted the survey, estimated that the rail link could be constructed in 400 working days at a cost of $123,167,000. An earlier survey had been made for a rail route between Prince George, B.C., and Fairbanks.

The Fairbanks-Teller survey was for a line of rail 730 mi. long that would enable the United States to ship overland to a spot within sight of the Russian-Siberian coastline across the Bering Strait. It was proposed to build a large port near Teller and there tranship across the strait to an extension of the Trans-Siberian Ry. A $26,528,000 port and rail yard was proposed at Port Clarence and the Puget Sound Bridge & Dredging Co. of Seattle was awarded a contract as engineer-architect of the port.

During the survey, temperatures ranged from 20 deg. to 60 deg. below zero. Special field camps and kitchens were designed for tractor and dog-team transportation, and survey instruments and motive equipment were winterized. The surveyors wore special clothing, and food was taken in to isolated parties by dog teams and airplanes.

Construction Bridge at Garrison Dam Designed for Maximum Salvage

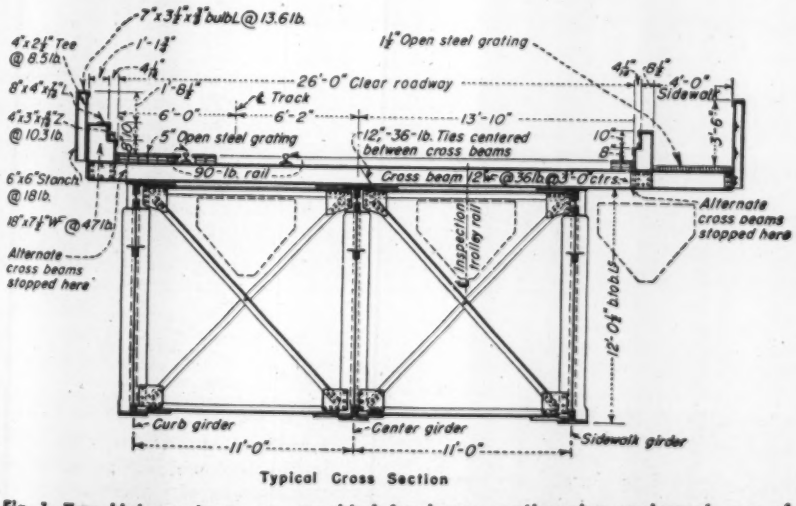
***Contents in Brief**—As one of four preliminary elements in the construction of Garrison Dam, work has been started on a 1,350 ft. highway and railway construction bridge across the Missouri River at the site of the dam 75 mi. northwest of Bismarck, N. D. Designed for maximum salvage upon removal, the bridge has an all-steel, field-bolted superstructure and special piers supported on long tubular steel piles driven to a substantial resistance.*

TUBULAR STEEL PILES of ¾-in. welded plate, 24 in. in diameter, at least 100 ft. long, driven and jetted to a resistance of 150 tons each are only one of the unusual features of the construction bridge now under contract over the Missouri River at the site of Garrison Dam, 75 mi. northwest of Bismarck, N. D. Although designated a semipermanent bridge with an expected usefulness of about six years, it was designed for strength and stability equal to that of permanent bridges carrying a combined railway-highway-pedestrian traffic.

The superstructure includes three lines of simple-span deck girders in nine 147½-ft. spans for an over-all length of 1,350 ft. It will cross the river on an 18-deg. skew. Designed to carry both railway and highway traffic, the bridge will have a 26-ft. roadway for two traffic lanes, in addition to one 4-ft. sidewalk. A standard-gage railway track with 90-lb. rails also occupies one of the highway traffic lanes (Fig. 1).

In keeping with the purpose for which it is intended—that of transporting heavy earthmoving equipment and construction materials—design loads include Cooper's E-50 live load on the single railway track in combination with 158,000-lb. earthmoving vehicles at 75-ft. intervals with a maximum axle load of 79,000 lb. This highway live load is considerable in excess of the standard H-20, S-16 loading commonly specified in highway design.

Wind loads included in the design are similar to those of conventional design for railroad-highway viaducts, being 30 lb. per sq. ft. on an area 1½ times the vertical projection for the loaded structure, plus 300 lb. per lin. ft. of railway live load; or 50 lb. per sq. ft. on 1½ times the exposed area for the unloaded structure.



Typical Cross Section

Fig. 1. Two highway lanes are provided for heavy earthmoving equipment, one of which includes a standard gage railway. All field connections are to be bolted, except main girder splices.

The construction bridge at Garrison Dam, termed the key-dam in the Pick-Sloan plan for development of the Missouri River Basin, is one of four initial elements of the project placed under contract this year and which must be completed before construction of the dam proper is started. The other three elements include 10.5 mi. of access railroad, 13.5 mi. of concrete paved access highway and a site for a town which is to be erected near the site of the dam. Facilities will be provided for temporarily housing a maximum of 5,400 persons.

Site access facilities

Both the highway and the access railroad will be built from a point 4 mi. southeast of Coleharbor, N. D., into the east, or spillway, side of the dam. By means of the construction bridge they will be carried across the river to transport materials, equipment and men to the west bank for constructing the intake, outlet works and powerhouse which, together with other concrete appurtenances on that side of the river, will involve the placement of nearly 1,000,000 cu. yd. of concrete.

At present, there is no bridge over the Missouri in the vicinity of the site chosen for the dam closer than Bismarck, 75 mi. downstream and Elbowoods, 47 mi. upstream from the site. Moreover, installation of the construction bridge will preclude the necessity of building some 18 mi. of access railroad from Stanton, N. D. to the west abutment of the dam.

The bridge will be located about 1,000 ft. below the axis of the dam, inside of the downstream toe. Present plans contemplate its removal some time during the fifth year of construction (1951) at which time initial closure of the dam is scheduled. At that time a temporary railroad and highway

crossing will be provided on a berm to be built integrally with the downstream slope of the dam.

Designed for maximum salvage

In view of the requirements for its eventual removal, the bridge was designed to permit ready dismantling and to provide maximum salvage. Field splices of all main girders are to be riveted but all other field connections, in general, will be bolted, using structural bolts with automatic locking nuts.

The structural arrangement of the floor system is rather unusual as it is designed to carry three types of traffic —railway, heavy earthmoving equipment and pedestrian—while at the same time it is reasonably lightweight and easily dismantled. The proposed floor system consists of crossbeams bolted to the girders and carrying 5-in. open steel grating for the roadway and 1½-in. open steel grating for the sidewalk. Curbs and handrails are made up of sections of rolled beams bolted to the cross-beams and carrying longitudinal angles, tees and Z-bars.

Three lengths of 12-in., 36-lb. wide-flange beams will be bolted to the top flanges of the three lines of girders to carry the floor and sidewalk. Crossbeams carrying the two lanes of highway traffic are spaced 3 ft. apart, with alternate beams cantilevered out to carry the roadway curb and guard rail, sidewalk and handrail on one side; and the roadway guard and rail on the other side. Additional crossbeams are bolted to the two girders under the railway track, midway between the longer crossbeams, to serve as rail ties. This arrangement provides an 18-in. spacing of beams under the railroad track, a 36-in. spacing under the other half of the road carrying highway traffic only, and a 6-ft. spacing for the sidewalk, guard rail posts and sidewalk handrail.

Traction frames are to be installed at the one-third points of each span to provide increased rigidity for railroad track. Due to the 18-deg. skew of the spans, the three end crossbeams at each pier are provided with a sliding bearing and stiffener diaphragm on one of the outer girders, each side of the pier.

Tram rails for inspection

Three continuous lines of tram rail are to be suspended from the crossbeams, one between each pair of girders and one under the sidewalk to carry manually operated cars to permit inspection of the girders and floor system during its useful life.

Light standards spaced 60 ft. apart along the sidewalk, with luminaires mounted 28 ft. above the roadway are to be installed for night traffic.

The girders are 12 ft. 0½ in. back-to-back of flange angles and spaced 11 ft. apart. Crossframes are spaced 17½ ft. apart. The center girder is offset

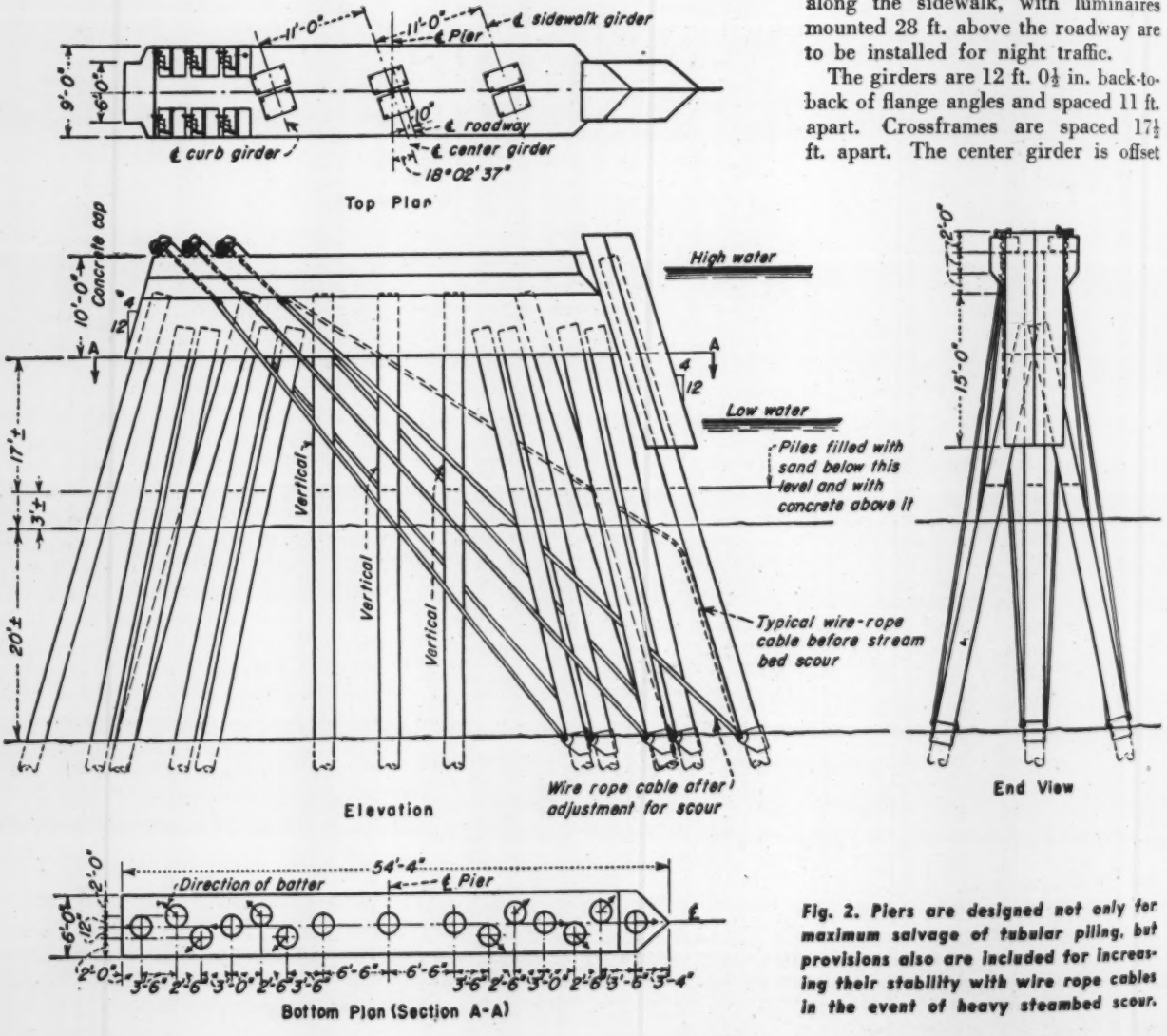


Fig. 2. Piers are designed not only for maximum salvage of tubular piling, but provisions also are included for increasing their stability with wire rope cables in the event of heavy steambed scour.

10 in. from the centerline of roadway, towards the railroad track, to partially equalize the dead and live load reactions to the three girders. Even then the girder on the sidewalk side of the bridge is considerably lighter than the other two which contain virtually equal amounts of main materials, although the center girder carries the heavier load.

Principal elements of the sidewalk girder are: $\frac{9}{16}$-in. web; a top flange made of two full-length 8x6x$\frac{1}{2}$-in. angles and two 8x6x$\frac{1}{2}$-in. angles 88 ft. long; and a bottom flange of two 8x8x$\frac{5}{8}$-in. angles with one 18x$\frac{5}{8}$-in. cover plate. There are no top cover plates on any of the girders.

Elements comprising the other two girders are much heavier. Webs are $\frac{9}{16}$-in. plates; the top flanges are made of two full-length 8x6x1-in. angles, two angles 8x6x1-in. by 111 ft., and two side plates 13x$\frac{1}{2}$-in. by 66 ft. The bottom flanges contain two 8x8x1$\frac{1}{8}$-in. angles with three 18x$\frac{3}{4}$-in. cover plates having lengths of 108 ft., 90 ft., and 62 ft. Each girder will have three splices —a shop splice at the centerline and a field splice at the one-third points.

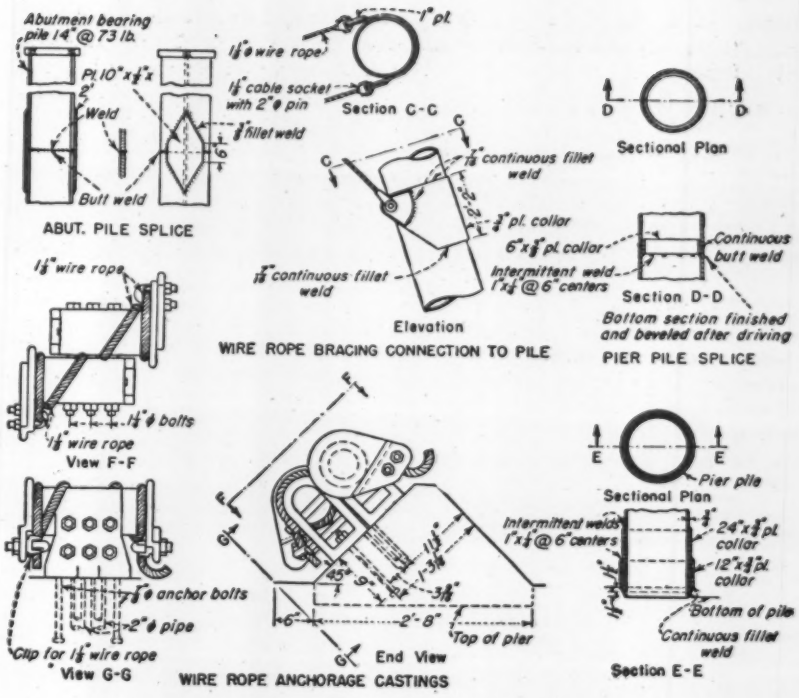


Fig. 3. Special construction features of the substructure include: Abutment H-beam pile splices, pier tubular-pile splices and reinforced cutting edge wire rope bracing connection to tubular piles and cast steel anchorages for the wire rope

Piers designed for easy removal

Although many innovations are incorporated in the design of the superstructure due to its status of semi-permanency, many details of the eight piers have been boldly conceived to provide a stable structure yet one which can be erected economically and removed with the greatest amount of salvage.

Actually, each pier consists of a concrete-encased double-trussed cap supported on fifteen 24-in. dia. tubular steel piles, only three of which are to be driven vertically. The other twelve are to be driven on a batter of 4-in. horizontal to 12-in. vertical; four being battered parallel to the centerline of the pier and eight at an angle of 41½ deg. with the centerline of pier (Fig. 2).

A cross-section through the pier cap shows it to be 9 ft. wide at the top, 6 ft. wide at the bottom and 10 ft. deep. Pier caps are 47 ft. long at the top with the downstream end sloping 1 on 3 and the upstream end fitted with a cut-water nose 21 ft. deep made of plates and angles and sloping 1 on 3.

The structural arrangement of pier cap, which is to be of all-welded construction, includes two 15-in. channels extending horizontally along the bottom, set 4 ft. 9 in. back-to-back and welded to a continuous 72x$\frac{5}{8}$-in. bottom cover plate. The cover plate extends 7½ in. beyond the channels to carry the concrete encasement.

Extending lengthwise of the pier cap, near the top, are two 4x4x½-in. angles spaced 4 ft. 9 in. apart and tied together with ¾-in. rods to form the top flange of the two trusses. Top and bottom flanges are tied together with welded 15-in. channel diagonals sloping 60 deg. with the vertical to form the web system of the trusses.

The 72x$\frac{5}{8}$-in. plate forming the bottom surface of the pier caps will be used as a template for driving the fifteen tubular steel piles required for each pier. Holes are to be accurately located according to the pile driving plans and made large enough to accommodate the 24-in. dia. piles, with due allowance made for the slope of the batter piles.

Although the piles will be embedded from 3 to 6 ft. in the concrete of the pier caps they also will be rigidly fastened to the bottom steel plate, after driving, by 4x½-in. steel collars welded both to the piles and the plate. The piles probably will be burned off just below the cap, prior to their removal during the dismantling of the bridge.

Due to the nature of the existing riverbed, special precautions are provided in the design of the piers to insure their stability despite any reasonable scour. This consists of a system of 1½-in. (6x19) steel wire ropes connected to the six upstream batter piles at the elevation of maximum scour and extending up through concrete haunches on the sides of the pier caps and anchored to special anchorages provided on top of the piers at the downstream end. Special concrete seats cast monolithically with the concrete in the pier caps provide bearing for the cable anchorages.

Substantial scour anticipated

It is estimated that scour may occur to a depth of about 20 ft. below the lowest point in the streambed at the site of the construction bridge, which is about 47 ft. below the top of the piers. Accordingly, the construction specifications provide for the six upstream piles of each pier to be driven to within about 40 ft. of final position. Then the wire rope connection plates

will be welded to the piles below the bottom of the pier caps. Two 1¼-in. wire ropes will be attached to each plate using cable sockets and 2-in. pins through holes provided in the plates (Fig. 3).

The six upstream piles then will be sunk to final position with the wire ropes being drawn loosely up along the piles. After the piles are seated the wire ropes are to be threaded through 2-in. dia. holes provided in the haunched portions of the pier caps, pulled reasonably taut and attached to the wire rope anchors on top of the piers.

At this point the wire ropes will add no stability to the piers, as they will not be under straight-line tension between pile plates and pier anchorages. However, should the riverbed scour down to elevation of the connection plates welded to the piles, the wire ropes will be loosened from the cast-steel anchors atop the piers, drawn fully taut under a tension of about 10,000 lb. per rope and reconnected to the anchors to induce additional rigidity in the pier which was lost through the scouring of the riverbed.

This method of providing additional stability is reported to have been used on similar bridges, with final tension being applied to the wire ropes by applying a pulling load on the cables with a crane boom located on top of the bridge.

Piles designed for heavy load

Specifications require that the 24-in. tubular steel piles be driven to a point at least 100 ft. below the top of piers, and as much farther as necessary to develop a safe load capacity of 150 tons each. Piles are to be open-ended with the bottom 2 ft. reinforced with two ¾-in. plate collars and beveled to provide a cutting edge (Fig. 3). They will be jetted, using water jets operated in pairs, with air jets similarly operated, and supplemented by the work of the pile hammer. The tubular piles will have special splices (Fig. 3).

Specifications require each water jet to discharge at least 1,000 gpm. through 4-in. jet pipes under a nozzle pressure of 125 psi. The compressed-air jets, which are to be attached to and discharge at the nozzle of each water jet are specified to deliver 250 cu. ft. per min. of compressed air at 80 to 100 psi.

After being driven to final penetration the piles will be filled with clean sand to a point about 3 ft. below low-water in the river, with the remainder of each pile being filled with concrete. In the design of the piles, no allowance was made for the supporting power of the concrete and sand filling within them. Similarly, in making load tests on the pier piling, jets will be used to release all skin friction on the piling above the elevation of the assumed maximum scour as a safeguard against future reduction of the bearing capacity of the piling.

Abutments built with H-piles

Abutments are of cantilever design about 23 ft. high and each supported on twenty-six 12x12-in., 73-lb. H-beam steel piles, at least 65 ft. long and driven to a 75-ton resistance each. They will be spliced where necessary, as shown in Fig. 3.

Some rather large items are shown in the estimated contract quantities. They include 5,100,000 lb. of structural metalwork in addition to roadway and walkway grating, railway track, inspection tram rail equipment, and the lighting system; 15,000 lin. ft. of tubular piling and 6,500 lin. ft. of rolled beam piling; 46,000 lb. of reinforcing steel and 1,520 cu. yd. of concrete.

Designed by consultants

A contract in the amount of $1,303,168 for furnishing all materials and erecting the construction bridge was awarded on April 26 to the Missouri Valley Constructors, Inc., Leavenworth, Kansas and Winston Bros. Co., Minneapolis, Minn. All designs of the bridge and construction plans were prepared by Howard, Needles, Tammen and Bergendoff, consulting engineers, Kansas City, Mo.

Construction of the bridge, which is expected to take ten months, will be under the jurisdiction of Lt. Col. Delbert B. Freeman, district engineer, Omaha District, U. S. Army Engineers, reporting to Brig. Gen. Lewis A Pick, division engineer, Missouri River Division.

Erosion of Shores of Lake Ontario Studied by groups in Canada and U. S.

Erosion of the shore line of the western part of Lake Ontario—extending from Toronto, Ont., through Burlington at the extreme western end, as far as the international boundary at the Niagara River has become so serious that there has been formed the Niagara-Toronto Lake Shore Protective Association.

This body, representative of local residents and municipalities, to solve the many problems caused by the erosion, is seeking aid from both federal and Ontario provincial governments. Some of the most serious erosion has taken place in Clinton Township, between Beamsville and Vineland, in the Niagara Peninsula, where the shore line has been cut back between 75 and 100 ft. in the last forty years. The lakeshore road has had to be relocated three times in that vicinity and today some parts of it are closed and others are open to motorists only "at their own risk."

No plan to correct this condition has yet been evolved.

In New York State the U. S. Engineer office at Buffalo has completed a cooperative beach erosion study of Niagara County in conjunction with the Niagara frontier planning board. The report was published in 1943 in House Document No. 271, 78th Congress, first session.

The purpose of the study was to determine the best method of preventing further erosion of the Niagara County lake shore and to develop plans for the building and maintenance of beaches on publicly-owned properties at and near Wilson and Olcott. The report gave alternate plans for protective structures and concluded that a riprap type of protection combined with slope treatment would be the most suitable type for use on the Niagara County shore line.

The Beach Erosion Board stated its opinion in accordance with the law, that no federal interest was involved in the protection of the Niagara County shore line and that it was not advisable for the United States to adopt a project for the improvement of the beaches and that no share of the cost of any improvement of the shore line should be borne by the United States.

Fig. 1. Boeing B-29 superfortress with 60,000-lb. dual main-wheel loads used in runway tests at the Marietta, Ga., airfield.

Tests of Flexible Pavement For Airfields Runways

Part II—Test Results and Application

***Editor's Note**—Test results and records of experience gained by Army Engineers since 1942 have established a design theory and developed a series of design curves for airport runways with flexible pavements. The test runways, methods of construction, type of loading and the devices for measuring load effects were described in Part I of this article (ENR July 11, vol. p. 36). In the following text and illustrations, the deflection and pressure measurements obtained and the analysis followed in determining design curves are outlined.*

TESTS OF RUNWAY PAVEMENTS conducted by Army Engineers since 1942, as described in Part I of this article (*ENR* July 11, vol. p. 36), have developed deflection and pressure measurements and pavement service records of importance. The application of the test determinations to design curves for flexible pavement is discussed in the article that follows. These design curves are predicated on the California bearing-ratio method of evaluating pavement base materials.

Developed in the late thirties by the California Division of Highways, the California bearing-ratio method of flexible pavement design was adopted by the Army Engineers, developed further and extended to cover the heavy wheel loads of military airplanes. Tentative design curves based on tests and on the design, construction and operating experiences of the Army Engineers were prepared, and as revised for 1943 are included in the "Engineering Manual," of the Army Engineers.

The California bearing-ratio method of design is wholly empirical. It consists of determining the relative stability of a subgrade soil by a penetration test known as the California bearing-ratio test, and the application of the relative stability value to empirical design curves, similar to those shown by Fig. 7, to determine the required total thickness of base and pavement. The relative stability value is designated as the California bearing ratio. The phrase is usually abbreviated to CBR. In the CBR test a circular piston, 3 sq. in. in area, is forced into a soil and its load-deformation characteristics noted. The load at a given deformation, usually 0.1 in., is expressed as a percentage of a standard which was based on tests on crushed stone. This percentage is the CBR value.

The methods of making CBR tests for the runway pavement studies were described in Part I of this article. A reason given by Army Engineers for favoring the CBR method of design is that it is particularly useful because it utilizes a test that can be conducted on samples that have been adjusted to a design density and moisture condition. The method can also be used to evaluate different base materials and to determine the thickness and construction sequence of individual layers if more than one base material is used in the section.

Deflection gages were periodically calibrated for accuracy. In the tests

TABLE I—EFFECT OF 20 PERCENT REDUCTION IN BASE THICKNESS ON SUBGRADE DEFLECTIONS UNDER SINGLE-WHEEL LOADS OF 30,000 AND 60,000 LB.

Test	Full Design		80 Percent of Full Design		
	Base Thick. In.	Deflection In.	Base Thick. In.	Deflection In.	Ratio of Deflection[1]
30,000-lb. Single-Wheel Load					
Marietta	28.7	0.13	23.0	0.29	2.2
Stockton	25.1	0.13	20.1	0.20	1.5
Barksdale	23.8	0.07	19.0	0.13	1.9
60,000-lb. Single-Wheel Load					
Marietta	38.0	0.18	30.4	0.38	2.1
Stockton	33.3	0.17	26.6	0.27	1.6
Barksdale	31.5	0.13	25.2	0.24	1.9

[1] Deflection for 80 percent thickness divided by deflection for full thickness.

TABLE II—LOAD VARIATION DUE TO "REV-UP" AND VIBRATION OF A B-24

Load Variation Due to "Motor Rev-up"

Wheel	Dead Load in lb.	Load in Percent Referred to Motors Dead Condition			
		0 rpm.	1,000 rpm.	1,500 rpm.	2,400 rpm.
B-24, Wright Field					
Right main	25,400	100.0	97.5	91.6	75.6
Left main	25,800	100.0	99.0	91.0	75.6
Nose	4,600	100.0	144.0	177.0	210.0
B-24, Marietta					
Right main	25,240	100.0	99.0	94.0	85.0
Left main	25,240	100.0	97.0	90.0	79.0
Nose	5,680	100.0	129.0	192.0	260.0

Load Variation Due to Vibration*

B-24, Marietta

Rpm.	Percent Variation of Load		Vibration Impulses per Second	
	Main Wheel	Nose Wheel	Main Wheel	Nose Wheel
1,600	1.2±	1.8±	2.1	1.6
1,800	1.4±	4.4±	1.9	0.8
2,400	2.9±	5.7±	1.6	0.8

* Maximum variations in load due to vibrations in percent of static load for a given wheel.

TABLE III—WHEEL LOAD COVERAGE AT WHICH MAP CRACKING OCCURRED IN THE STOCKTON AND BARKSDALE TESTS.

Field Test	Stockton		Barksdale	
Wheel load, lb.	25,000–40,000		20,000–50,000	
Permanent, in.	30	38	18–21	29–34
80 percent, in.	24	30	14½–17	23–27
Coverages at 80 percent	1,500	750	750–3,000	1,000–5,000

on the Marietta runway it is believed that for moving loads, in which the time consumed for testing was brief, the instrument accuracy was within 0.002 in. Due to the inherent tendency of amplifying equipment to "drift" over longer periods of time it is believed that overall accuracy for standing loads is within 0.004 in. With a calibration before and after the tests and giving consideration to "drift," it is believed that the overall accuracy of pressure cells was within 5 percent for moving and 7 percent for standing load. The actual deflection and pressure measurements obtained were influenced by many factors so they may not be as reliable as the accuracy of the instruments used to measure them. With analysis, comparison, correction and averaging carefully applied, the charted measurements, however, reach great accuracy.

Only representative charts of deflections can be given and selection is made from the Marietta tests as shown by Fig. 2, 3 and 4. Fig. 2 and 3 show deflection vs. thickness and deflection vs. load as coordinates. A 60,000-lb. single-wheel load obtained by extrapolation is shown on Chart A of Fig. 2 and 3. Fig. 4 shows the deflections obtained from repetitional loading on 20 and 30-in. rigid bearing plates.

The data points for the wheel-load deflection curves of Fig. 2 and 3 are the average of all deflection values secured from the three lines of gages for each depth of base, type of wheel and load, respectively. Moving loads combine both towing and taxiing conditions as the deflections produced did not indicate differences that warranted two charts. In the same way and for the same reason, standing loads represent the conditions of plane standing with motors dead and with motors running at 1,000 rpm.

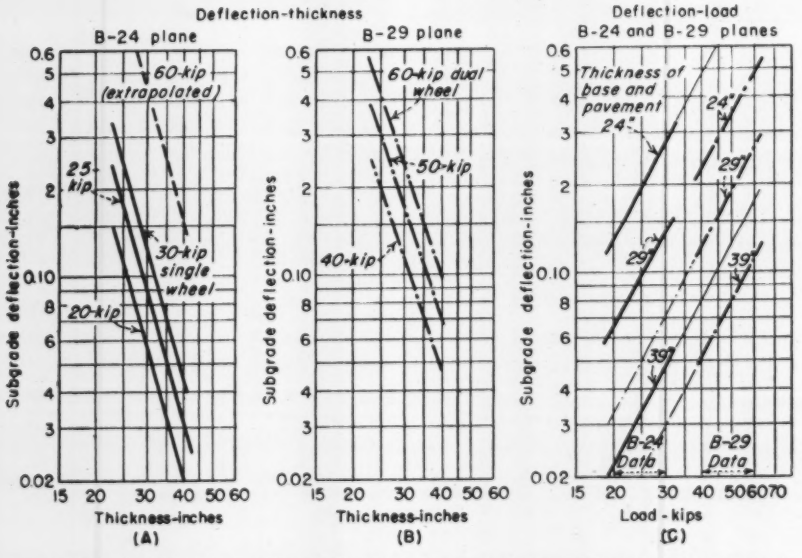


Fig. 2. Standing-load deflections of subgrade caused by B-24 and B-29 planes in Marietta runway tests, which included tests with motors running at 1,000 rpm.

Deflection analyses

The charts of Fig. 5 show the curves for the 60,000-lb. B-29 dual wheel loads superimposed on the curves for single-wheel loads. It is seen that the curve of the B-29 dual wheel approaches that of a 30,000-lb. single wheel at about a 10-in. depth of base. It approaches the curve for a 60,000-lb. single-wheel load at a thickness of about 75 in. These facts indicate that for very thin base courses each tire of a 60,000-lb. B-29 dual wheel produces the same deflections as an independent 30,000-lb. single wheel and that for very thick base courses the 60,000-lb. B-29 dual wheel produces the same subgrade deflections as does a 60,000-lb. single wheel. The figures of 10 in. and 75 in. are important to notice in connection with vertical pressure and shear values.

These pressure and shear values are shown by the chart Fig. 6. Here the theoretical vertical pressures produced by a 30,000-lb. and a 60,000-lb. single wheel and a 60,000-lb. B-29 dual wheel are plotted against depth. Also shown are pressures measured during the Marietta tests; they are seen to be in close agreement with the computed pressures. It is indicated that the ver-

tical pressure under a single tire of a 60,000-lb. B-29 dual wheel at a depth of about 17 in. is about the same as that under the 30,000-lb. single wheel at the same depth. Beyond a depth of about 80 in. the vertical pressure produced under a 60,000-lb. B-29 dual wheel and a 60,000-lb. single wheel is about the same. On the chart of computed shears the corresponding depths are 20 in. and 80 in.

Deflections increase materially with moderate reductions in base thickness. A single example tabulated from the deflection charts is given by Table I. These figures indicate that a decrease in base thickness of 20 percent results in a subgrade deflection from 1.5 to is of full-design thickness.

Based on the deflection-test measurements, an increase of 40 to 50 percent in wheel loads is necessary to produce deflections equivalent to those resulting from a 20 percent reduction in the thickness of the base as shown by the table.

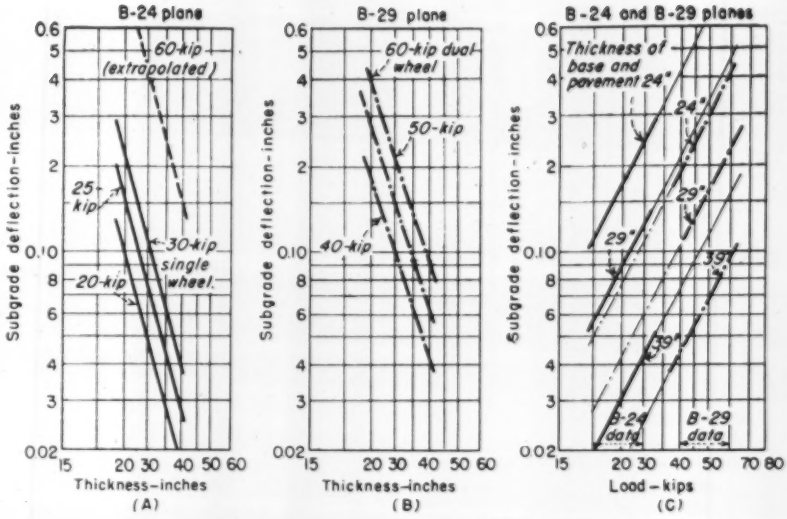


Fig. 3. Moving-load deflections of subgrade caused by B-24 and B-29 planes in the Marietta runway tests, which included both towing and taxiing conditions.

Load conditions compared

Comparison of deflections from moving and standing wheel loads show that to obtain the thickness of pavement required by standing loads, moving wheel loads must be increased by 10 percent in the Marietta tests, 35 percent in the Stockton tests and 30 percent in the Barksdale tests. It is indicated that the subgrade deflections produced by moving wheel loads will vary with the speed of the moving wheel, and that a slowly moving wheel will produce deflections approaching those of a standing wheel. As the speed of the wheel increases, it is stated as belief that the deflection will decrease in a ratio that cannot be determined with the data available. In the tests the average wheel speeds were about 5 mi. at Marietta, 7 mi. at Barksdale and 10 mi. at Stockton.

Analyses of the deflection measurements indicated that greater subgrade deflections were permissible under thick bases than under thin bases. The specific figures arrived at are 0.05 in. for a 10-in. base and 0.24 in. for a 50-in. base. These figures should be considered as comparative, not as absolute values.

The tests showed that the effects on the subgrade were no greater with the plane standing with motors running than with motors stopped. No increase in wheel load followed with motors "revved-up" to 2,400 rpm. Tests of load changes due to "rev-up" and to vibration gave the figures shown in Table II.

A main purpose of all the test runways was to determine the comparative sufficiency of various types of flexible pavement structure. Only in the most general terms is valid comparison possible. This is so because of lack of comparable data, because of opposing testimony and of abnormal conditions of structure. At Marietta especially, the weather and other construction conditions produced saturation of base and subgrade that continued throughout the tests.

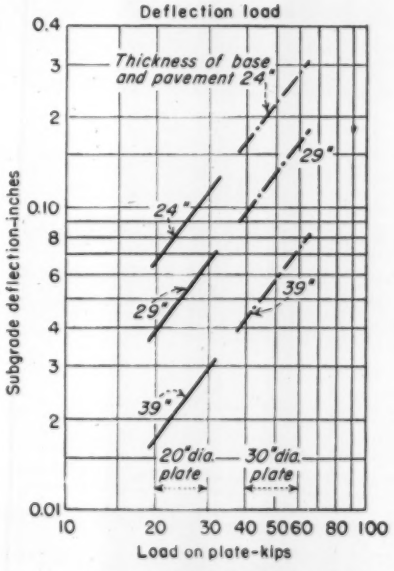


Fig. 4. Subgrade deflections from loaded 20- and 30-in. bearing plates as determined by the Marietta runway tests.

An overall conclusion from all field tests was: Where failure occurs in flexible pavement from inadequate thickness of base or inadequate subgrade support it occurs in a relatively few operations of traffic.

Macadam Base—All the macadam bases at Marietta carried their loads with only slight evidence of weakness in the thinnest base. During the testing, all the macadam bases contained water of varying depths up to within a few inches of the top following rains. At Stockton the comparable base was crushed gravel to full depth and at Barksdale it was a blend of crushed soft limestone and sand to full depth. The deflection data do not indicate that the macadam bases were appreciably better than the other two.

Sand-clay Base—Failure of the sand-clay base at Marietta did not make any comparison with macadam valid. This sand-clay base was saturated by rain before paving and remained water soaked and unstable during the testing period. In contrast, tests at Eglin field of a sand-clay base, with an asphalt-concrete surface, on a free-draining sand subgrade warranted the following statement:

> A CBR value of 60-in. sand-clay bases over clean, well-drained sand subgrades, when surfaced with 1½ or 3 in. of good quality asphaltic concrete, is satisfactory to prevent shear deformation in the base for capacity operation of all wheel loads up to 50,000 lb.

Layered Base—At Barksdale, com-

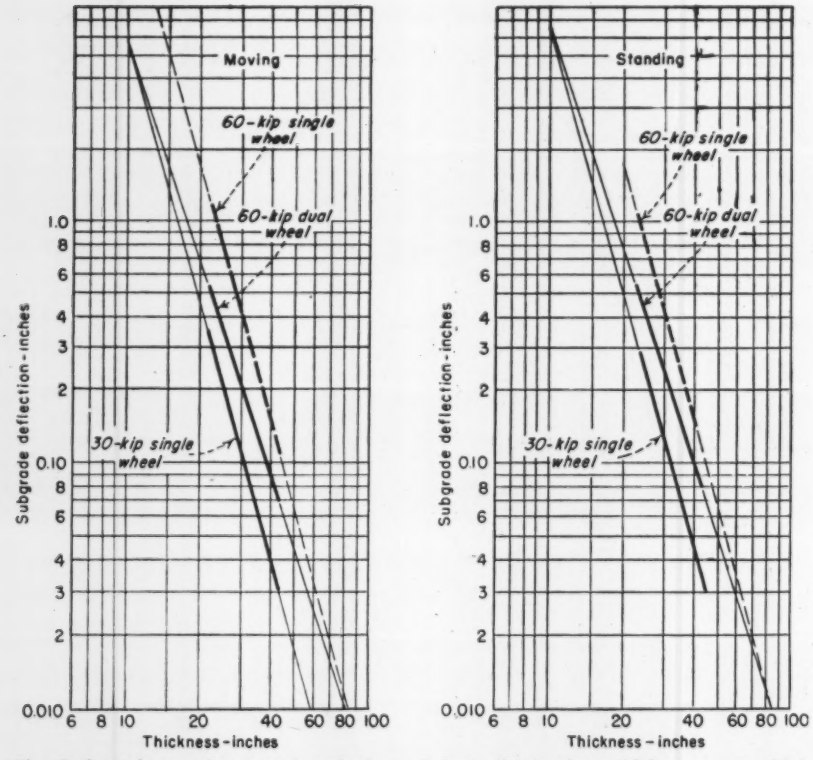


Fig. 5. Superimposed curves for single and dual wheels show thicknesses at which the deflections for different wheels are equal.

parison was made between a layered base, with poor quality material in the lower layers, and a blend of crushed limestone and sand to full depth. The layered base failed quickly and from the analysis presented in the report it is indicated that the thickness over subgrade for layered-base design should possibly be 10 or 15 percent greater than when high-quality base material is used for the full depth.

Telford Base—The worst failure at Marietta was perhaps the telford pavement. It rutted and broke down quickly. The main causes of failure were: (1) Inadequate thickness; (2) lack of load distribution by the telford system, and (3) excessive entrapped moisture. The telford stone and sand cushion were virtually saturated, thus furnishing water to the clay subgrade which was remolded by punching down of the stone under wheel load applications. No quantitative conclusions were attempted but it was surmised that telford paving should be as thick as macadam.

Sand-Asphalt—Sand-asphalt on sand subgrade gave good results at both Marietta and Eglin. At Eglin the conclusion was:

> A thickness of 6 in. of mixed-in-place, good quality sand-asphalt (when properly cured) was adequate as a wearing course and was satisfactory to prevent shear deformation in the underlying unsaturated, noncohesive, free-draining sand with a CBR of 35 for all wheel loads in the traffic tests.

The sand-asphalt at Marietta suffered no deterioration under traffic and scuffed only slightly under locked wheel turns of B-29 war-planes.

Map-Cracking — Observations at Stockton and Barksdale of map-cracking of asphalt surfaces due to shear deformation in the subgrade showed an increase in the number of coverages required to cause its occurrence as the thickness of base and pavement increased. The data in Table III indicate that if the thickness of pavement and base is 80 percent of that required for permanent construction, map cracking of the pavement due to shear deformation in the subgrade may occur

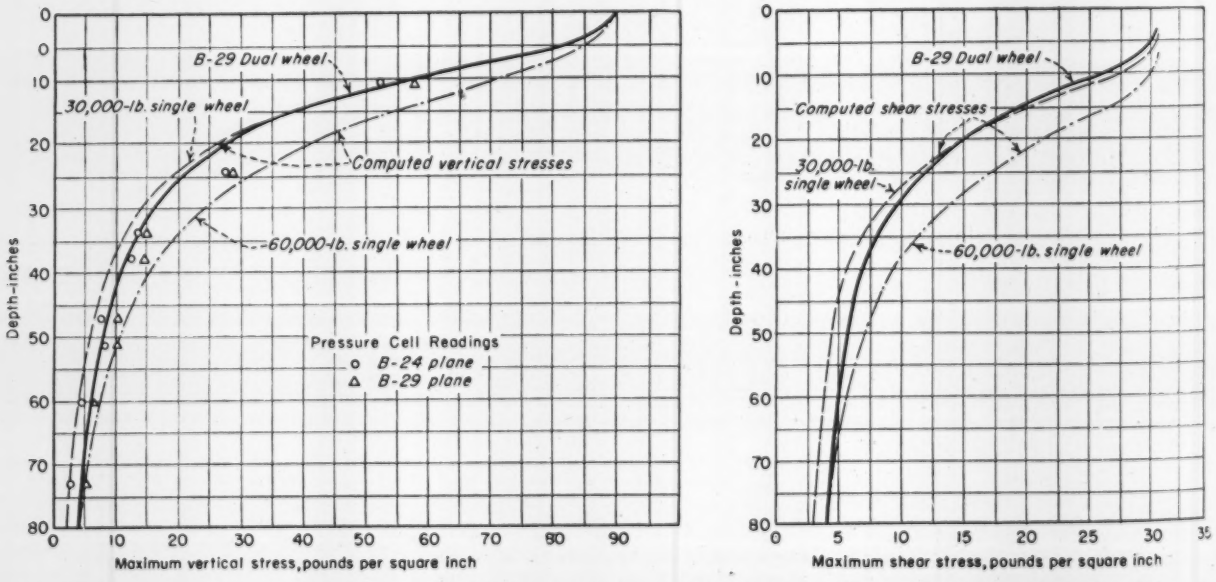


Fig. 6. Computed maximum vertical pressure and shear stresses at different depths imposed by single and dual wheels.

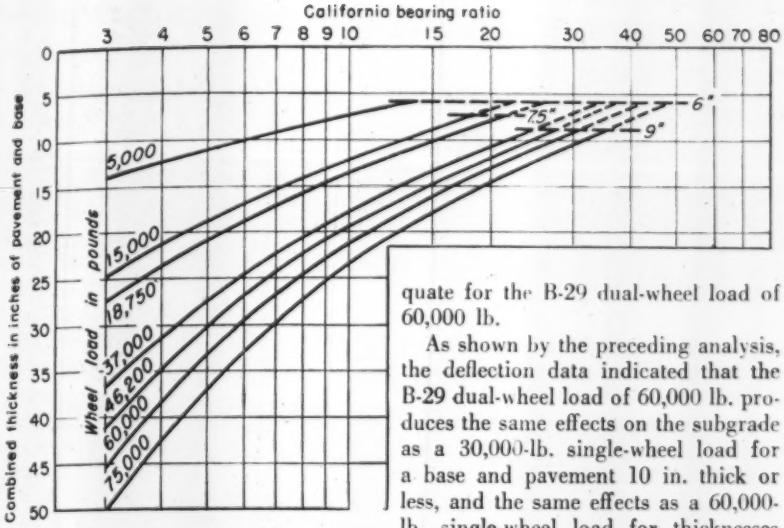


Fig. 7. Design curves for thickness of pavement and base for various single-wheel loads as computed by the California method.

between 750 and 5,000 coverages. Since requirements for limited-operation construction call for design thicknesses 80 percent of the thickness required for permanent construction, it may be seen that high maintenance may be expected in construction for limited operation.

Developing design curves

Based on the California method of design, as outlined early in this article, the Army Engineers had as there stated developed a series of design curves, Fig. 7, for various single-wheel loads. An early task was to correlate the runway test data, the pavement evaluation and failure records and other available data with the design curves already determined. In general, where a high type of base material was used so that no fracture occurred in the base, the data are in substantial agreement with the curves. The conclusion reported was: "Since the data indicate no necessity for revision, the present design curves are considered adequate."

A design curve was required for the B-29 60,000-lb. (30,000-lb. per tire) dual-wheel load. The basic concept employed was that for a given thickness of base there is a single-wheel load between the limits of 30,000 lb. and 60,000 lb. that will produce the same effects (stresses and strains) on the subgrade as the B-29 60,000-lb. dual wheel. The thickness of base and pavement that is adequate for this intermediate wheel is considered adequate for the B-29 dual-wheel load of 60,000 lb.

As shown by the preceding analysis, the deflection data indicated that the B-29 dual-wheel load of 60,000 lb. produces the same effects on the subgrade as a 30,000-lb. single-wheel load for a base and pavement 10 in. thick or less, and the same effects as a 60,000-lb. single-wheel load for thicknesses greater than 75 in. The data on vertical-pressure and maximum shear stresses also show 75 in. for the lower limit but from 17 to 20 in. for the upper limit. Since 10 in. is only a little more conservative it was selected.

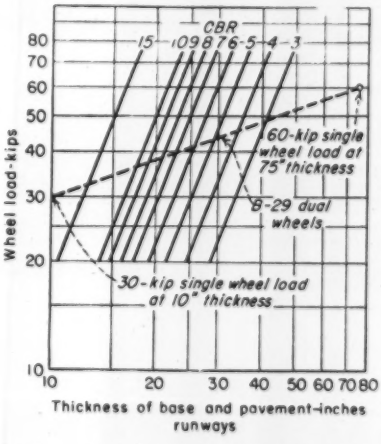

CBR
15 10 9 8 7 6 5 4 3
Wheel load-kips
60-kip single wheel load at 75" thickness
B-29 dual wheels
30-kip single wheel load at 10" thickness
Thickness of base and pavement-inches runways

Fig. 8. Points on dual-wheel design curve determined by replotting single-wheel design curve data.

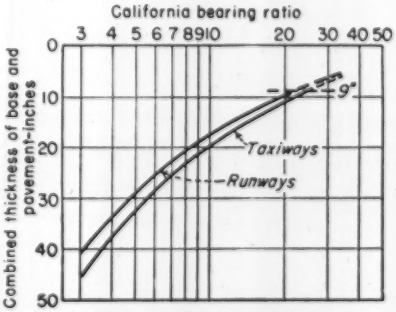


Fig. 9. Design curves for thickness of pavement and base for 60,000-lb. dual-wheel loads of B-29 planes.

Accordingly, a tentative curve for the design of runways for B-29 60,000-lb. dual wheels was prepared which coincided with the 30,000 lb. single-wheel load curve at a 10-in. thickness of base and pavement and with the 60,000-lb. single-wheel load curve at a 75-in. thickness.

To construct the B-29 design curve the single-wheel design curves in Fig. 7 were replotted as shown by Fig. 8. A line was then drawn from 30,000 lb., 10 in., to 60,000 lb., 75 in. The intersections of this line with the CBR curves gave the points for plotting the B-29 design curve shown in Fig. 9.

The curves of Fig. 9 and also those of Fig. 7 are for permanent construction at capacity operation. As defined, capacity operation is the maximum traffic that can possibly operate on an airfield for a period of about 20 years. It will also be seen in Fig. 9 that the curves require thicker bases for taxiways than for runways. This requirement is indicated by the previous analyses showing increases in deflections from standing and slowly-moving wheel loads. From all the information, a 25 percent increase was concluded as reasonable and this increase is embodied in the taxiway curve of Fig. 9.

Credits

The information from which this article has been prepared is the report, "Certain Requirements for Flexible Pavements for B-29 Planes" by the U. S. Waterways Experiment Station. This report was prepared as a result of a study requested by the Headquarters, Army Air Forces. The study was conducted by personnel of the Embankment, Foundation and Pavement Division under the supervision of W. J. Turnbull, chief of the division. The Marietta tests, which furnished the major part of the data for the study, were conducted under the supervision of J. M. Griffith, who prepared this part of the report. The analysis of the data and the application to requirements for B-29 planes were made by W. K. Boyd and Charles R. Foster. Gerard H. Matthes was director of the experiment station during the study. Personnel of the Engineer Board, Ft. Belvoir, Va., the Office of the Chief of Engineers, Washington, D. C., and Headquarters, Army Air Forces, Washington, D. C. assisted in planning and conducting the study.

Extending Compressed-Air Operations With Helium-Oxygen Air

***Contents in Brief**—Present-day capacity for volume production of helium gas at low cost revives hope of being able to use it to reduce the hazards of construction operations under compressed air. Physiological effects of work under compressed air are explained. Tests in compressed helium-oxygen air indicate that the decompression period can be shortened, thus extending the field of compressed air operations.*

EARLY ANTICIPATIONS of the beneficial use of helium gas in compressed-air operations are revived by a recent announcement by the U. S. Bureau of Mines that it now has enough helium-plant capacity to produce helium in large quantities at low cost. The use of helium-oxygen air was a live question twenty years ago and was then given intensive experimental study. At that time helium cost so much that its use in the volumes required for compressed-air work and submarine operations was economically impracticable. After the first experiments, investigation remained virtually in abeyance. The original studies still hold good, however, and under the new conditions of quantity production and low cost of helium they take on current interest.

The early studies disclosed that in a synthetic air of helium and oxygen men can work under greater pressures for more hours and can return to the open air sooner without the hazard of caisson disease. It appeared also that in normal compressed-air operations the helium-oxygen air can perform a positive service in safeguarding the decompression and restoration periods. These possibilities are important enough for a general review to be in order. It begins at fundamentals.

Physiology of Compression

In compressed-air work the body is subjected to three abnormal conditions: (1) Compression and entrance into a high-pressure atmosphere; (2) physical labor in this atmosphere for a varying period of time, and (3) decompression and return to normal atmosphere pressure. During compression and at the working pressure the body fluids and tissues absorb a large volume of air in accordance with the physical law governing the solubility of gases in liquids. By this law, if the body fluids were perfect liquids, they would at equilibrium have in solution twice as much gas at a pressure of two atmospheres as at a pressure of one atmosphere. Actually the body fluids only approximate the theoretical gas absorption but they do have in solution excess air in an amount depending on the pressure and the length of exposure to pressure.

Bubbles cause trouble

The absorption of this abnormal amount of gas while going under compression and working under pressure proceeds without trouble with normally healthy men. Any trouble comes during decompression and return to normal atmospheric conditions. As the pressure decreases the body tissues and fluids start to give up the excess gas that they have in solution and restore equilibrium with the exterior air pressure. However there is a lag due to the time required for diffusion of the tissue-bound gas into the blood stream and removal through the lungs.

If the rate of decompression is regulated to the degree of "lag" the excess gas diffuses gently and no considerable physical discomfort results. If decompression is too rapid the excess gas crowds to escape by forming bubbles. An anology of the two actions may be had in opening a bottle of soda water. If the cap is pried off suddenly the water bursts into an explosion of carbon-dioxide bubbles; if instead the cap is punctured by a fine needle hole the gas seeps out slowly and no disturbance of the liquid results.

In the decompression of compressed-air workers it is the formation of bubbles that causes trouble. If the bubbles occur in the spinal cord or the brain or in the blood stream so as to reach the heart in size, the danger is serious. If they occur in the muscular or other tissues the result is severe pains and cramps. Hence comes the common name "bends" for caisson disease. Incidentally it may not be generally remembered that caisson disease was perhaps first diagnosed and had purposeful medical study in America and was given its name in sinking the caisson for the New York tower of the Brooklyn Bridge in the seventies.

The gas in the body tissues after compression is nitrogen. Air is composed of about 79 percent nitrogen and 20 percent oxygen. The active oxygen is largely consumed by the activities of the compressed-air worker, leaving the inert nitrogen bound up in solution in the body tissues. A characteristic of nitrogen is high solubility and slow diffusion from solution; both are qualities that lengthen the time of safe decompression.

Compression economies

The length of time required for decompression is governed by the air pressure to which the worker is exposed and by the percentage of saturation of the body fluids with nitrogen. The percentage of saturation is dependent upon the length of time of exposure to the given pressure. It follows that at the same intensity of compression the productive working time becomes so short and the periods of compression and decompression become so long that compressed-air construction operations cease to be economically practicable.

The practicable limits do not permit of precise definition. In the last two decades material technical progress has been made through law and improved operating practices to safeguard compressed-air work. Broadly, what has been done is to set limits on work-

ing periods at different pressures, to require medical examination before and during employment, to control rates of compression and decompression by mechanical means beyond interference by workmen and to enforce hospitalization following decompression. The hospitalization commonly includes warm quarters to which the worker goes after decompression, undressed, has a hot bath and hot coffee and lies down for a rest. Symptoms of caisson disease are watched for by the job doctor and if they appear the worker is put into a recompression chamber where slow decompression commonly relieves the trouble.

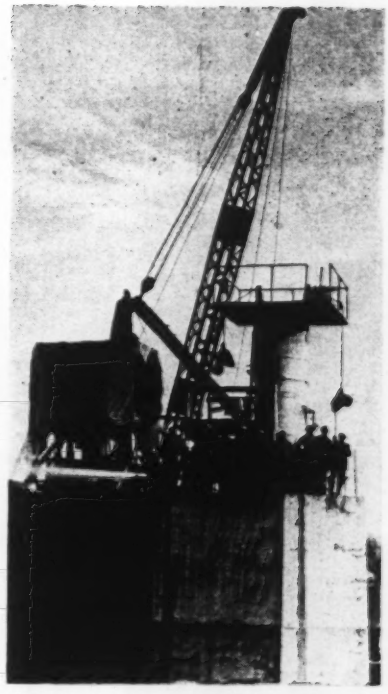
With these precautions, work in caisson sinking and tunneling up to 30-40 psi. is economically productive and caisson disease can be practically eliminated. Up to 50 psi., productive work is cut down rapidly and the hazards of caisson disease rapidly increased. Beyond 50 psi. only unusual necessity is the warrant for compressed-air work.

In diving the practicable working limits cease at about 200 ft. depth or at a pressure of about 100 psi. But at this depth the working time is measured in minutes and the hour or two spent in decompression by slowly lifting the diver to the surface involves possible great hazards.

Helium offers a remedy

It is the nitrogen in the atmosphere that sets the limits to compressed-air construction operations. Improvement in operating technique and medical care cannot be greatly extended by present means. Some means of modifying the working air to reduce the vicious action of nitrogen seems the most obvious possibility.

Consideration of a synthetic air as an aid in deep-water diving began in the early twenties. With the production of helium in volume for aviation, experimental work was undertaken. Helium is odorless and tasteless and substituted for nitrogen produces an entirely respirable air. Like nitrogen it is physiologically inert and being less soluble and more diffusible than nitrogen not so much is absorbed in compression and elimination is more gentle and rapid in decompression. In technical terms the solubility coefficient in water at 30 deg. is 0.008175 for helium and 0.0134 for nitrogen; the weight of the helium molecule is less than that of the nitrogen molecule in the ratio of 4 to 28.



Hazards in compressed-air operations such as this pier foundation job are expected to be materially reduced by the use of helium-oxygen air.

To secure factual evidence, tests were conducted in 1924 using animals largely, but with a few tests on men. A lot of the tests and tables of results were published by the Bureau of Mines in 1925. In brief, it was found that (1) with animals safe decompression could be accomplished in one-sixth the time with helium-oxygen air and (2) with men, decompression was made in one-fourth to one-eighth the time required in normal atmosphere.

Quoting freely from the report: From a comparative examination of all data as regards the decompression periods and the symptomatic and pathological findings it is very evident with similar exposures and decompression periods the conditions of the animals exposed to helium-oxygen mixtures is far better than those exposed to nitrogen-oxygen mixture. It is further shown by varying the decompression time that the periods producing equal symptoms and pathological effects are somewhere in the order of 1 to 3 or 4 for helium and nitrogen respectively. If it is assumed that the comparative relation obtained with small animals will hold in a fair degree with men, it can be concluded that the use of helium-oxygen mixtures will greatly decrease the safe period of decompression and will thus permit men to work for longer periods and under greater pressures.

Practical possibilities

The actual use of helium in compressed-air operations has been limited. In a report of the Department of Commerce in 1926 it was said:

"In the salvaging of the S-51, the helium atmosphere played an important role. At all times in the decompression chamber there was a full tank of a synthetic atmosphere of helium and oxygen, attached to a breathing apparatus. In case a diver developed bends, or in case recompression after the development of bends did not correct the condition with satisfactory promptness, the subject donned the breathing apparatus and inhaled the synthetic helium atmosphere while under the pressure. His nitrogen was then replaced by the helium, and this gas, being so much more easily eliminated, accelerated his recovery and often removed the symptoms in surprisingly short periods, as compared with the normal atmospheric air.

"Were it not for the high cost of helium, the possibilities of using a synthetic atmosphere of helium and oxygen during the entire period divers are under pressure would be almost unlimited. Instead of an hour on the bottom at 135 ft. depth, nearly two hours could be spent, without any increase in the period of decompression. This would permit of much faster work without the constant interruptions incident to the changing of shifts. Or, on the other hand, work might be carried on by a diver for an hour at a depth of more than 200 ft. This would make possible the salvaging of many wrecks which are not now considered practicable for salvage, on account of the enormous period necessary to decompress workers who might descend to the requisite depth."

These statements open a prospect for future use of helium in the decompression phase of compressed-air practice in tunneling and caisson sinking. In decompression, the volume of helium-oxygen air required is conceivably small enough to warrant investigation of the technicalities involved and balance them against possible gains in time and safety.

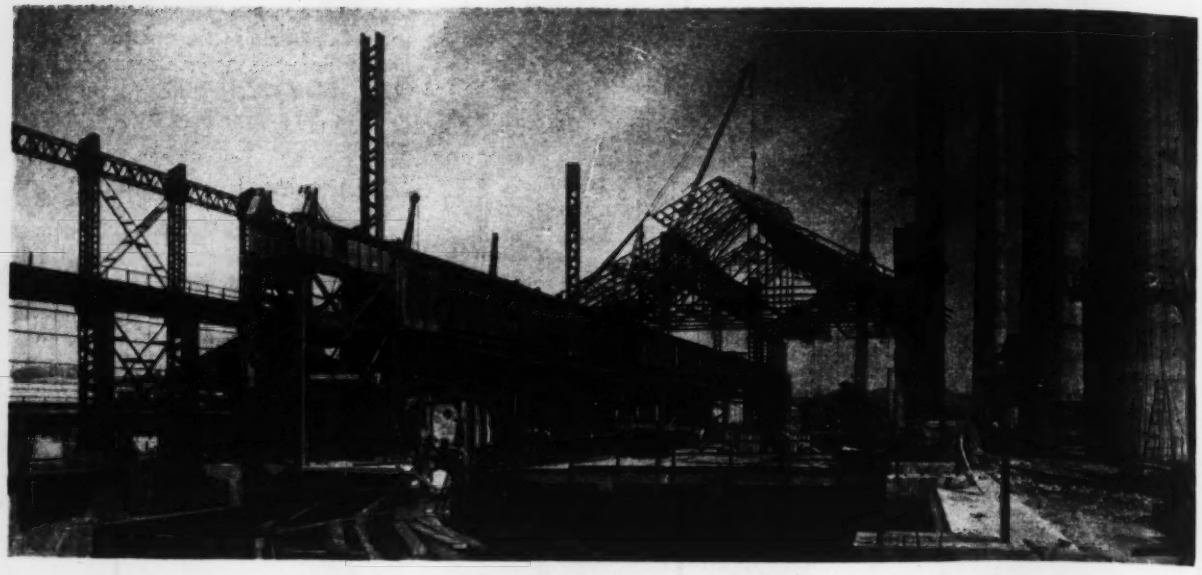


Fig. 1. Stiffleg derrick mounted on 60-ft. traveling tower erects steel for Volta Redonda openhearth.

Unusual Erection Problems Encountered at Brazil's Big Steel Plant

J. B. Gibson
Erection Dept., Bethlehem Steel Co.
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***Contents in Brief**—Erected by Brazilian labor under supervision of engineers from this country, the new steel mill at Volta Redonda will have a capacity of 350,000 tons of steel per year. Steel and equipment for the plant, totaling 168,000 tons, were shipped 8,000 miles to Rio de Janeiro and hauled by train 76 miles over a mountain range. Much of the erection equipment was improvised on the job, and special methods of erection were developed.*

As FINE A STEEL PLANT as ever was designed and built has begun operating at Volta Redonda, Brazil. Located about 52 air-miles from Rio de Janeiro, this completely integrated steel mill has a rated yearly capacity of 350,000 metric tons. Owned and operated by the Companhia Siderurgica Nacional (National Steel Co. of Brazil), the plant was erected with Brazilian labor under the supervision of engineers from this country, using equipment and steel fabricated in the United States.

Erection of a steel plant, such as the one at Volta Redonda, is a complex undertaking even under the best conditions. But when such a plant is located nearly 8,000 miles by water from the point of its fabrication, and native labor must be trained to do the erection, many special problems are encountered.

Such were the conditions under which this project was built in 2½ years during which time the author served as superintendent of erection of the open hearth and soaking pits division, and the structural steel and plate mills.

In brief, the plant consists of 55 coke ovens, including a benzoil and tar plant; a 1,000-ton blast furnace; an open hearth containing two 150-ton stationary furnaces, one 150-ton tilting furnace; a 600-ton molten pig iron mixer, two 225-ton teeming cranes, two 150-ton hot metal cranes (all metric-ton weights), and two charging machines for the furnaces; four soaking pits, 52 overhead cranes, an open-hearth mold yard and a stock yard.

The plant also includes a 40-in. blooming mill; a 72-in. plate mill; a rail and structural mill; and facilities for hot and cold stripping, galvanizing, tinning and finishing. Other structures include a 2,700-hp. powerhouse, a calcining building, a skull-cracker, a fully-equipped machine shop, a forge shop and a roundhouse. There are two all-welded gas holders in the plant. One tank, of 1,000,000-cu. ft. capacity is used for "bubble" on the line. The other, which has a capacity of 5,000,000 cu. ft., provides storage for the blast furnace gas.

No attempt will be made to give a detailed description of the entire plant, as the object of this article is to report some of the unusual erection problems encountered by the author in his connection with the project.

Transportation was the first thought and primary factor affecting erection. Being so far from the supplier, a seri-

ous equipment failure could mean months of delay. Consequently, much of the erection equipment was made on the job, even to welding ½-in. plates together to make 8x8x1-in. angles for the girder hitches. A 40-ton balance beam was made from an old set of crane girders, and all chokers had to be spliced in the field.

In addition to most of the heavy equipment, all small tools such as wrenches, dolly bars, shackles and even drift pins were made in the forge and machine shops. Pony trucks from locomotive engines were modified to transport 108-ton girders, as well as the heavy cabs for the hot metal and teeming cranes. Some of these pony trucks also were converted into crane trolleys.

Next in importance to transportation was the training of Brazilian laborers to erect the steel. All these workers, including foremen, bridgemen, riveters, crane operators and pushers were given an intensive training course prior to starting erection as well as on the job.

A night school was conducted two nights a week for six months in which the men were taught to tie knots; reeve block and falls; heat, catch, drive and buck rivets; climb columns and bolt steel; block a crane and give proper hand signals. The school was conducted by the author, assisted by Capt. A. Sao Thiago, who was a member of the Brazilian commission in Cleveland, Ohio, when the plant was purchased.

Some idea of the magnitude of the job can be gained from the fact that the steel shipped from this country totalled about 168,000 tons. It required 23 boat loads to haul the 7,000 carloads of steel, including refractories. To transport the steel from Rio de Janeiro to Volta Redonda, on the Central Railroad of Brazil required 675 train loads, with a maximum of 12 cars per train.

Rail transportation was difficult

Volta Redonda has an elevation of 1,232 ft. above sea level. But to reach there from Rio de Janeiro the railroad passes through 16 tunnels and over a mountain range at elevation 3,800. One of these tunnels, located near the top of the mountain pass, is 5 miles long with a sharp curve about midway of its length. A minimum clearance of 14 ft. 11 in. in height and 11 ft. 3 in. in width, in the tunnels, further aggravated transportation difficulties.

One of the major problems of transportation and erection involved the handling of 108-ton girders, 108 ft. long, and some 49-ton columns each of which were shipped from the states in two sections. The girders were 12 ft. 2 in. deep, with 3 ft. wide cover plates. These girders and column sections were handled in Rio with a derrick boat, and hauled to the plant site on the special railroad trucks. Eighteen of these large girders were moved over the mountain, one at a time, requiring from 10½ to 36 hours per girder.

Erection of the 49-ton columns was accomplished with the balance beam made from an old set of crane girders, using two 50-ton cranes to make the lift. (Fig. 2—left). It was necessary to improvise a toggle hitch made from a 14x14-in. timber faced with a ½-in. steel plate curved to take two 1¼-in. chokers. This same balance beam was used for all column erection where the drift was short and the hitch had to be lowered. It also was used to erect the tilting furnace and cabs on the teeming cranes.

Since there were no cranes available capable of erecting the 108-ft. long, 108-ton crane runway girders in one section, it was necessary to erect two half-sections separately and splice them at the centerline after they were in place. This required temporary falsework bents at the centerline of each span.

In some cases the temporary supports were two timber-frame bents spaced about 12 ft. apart at the center

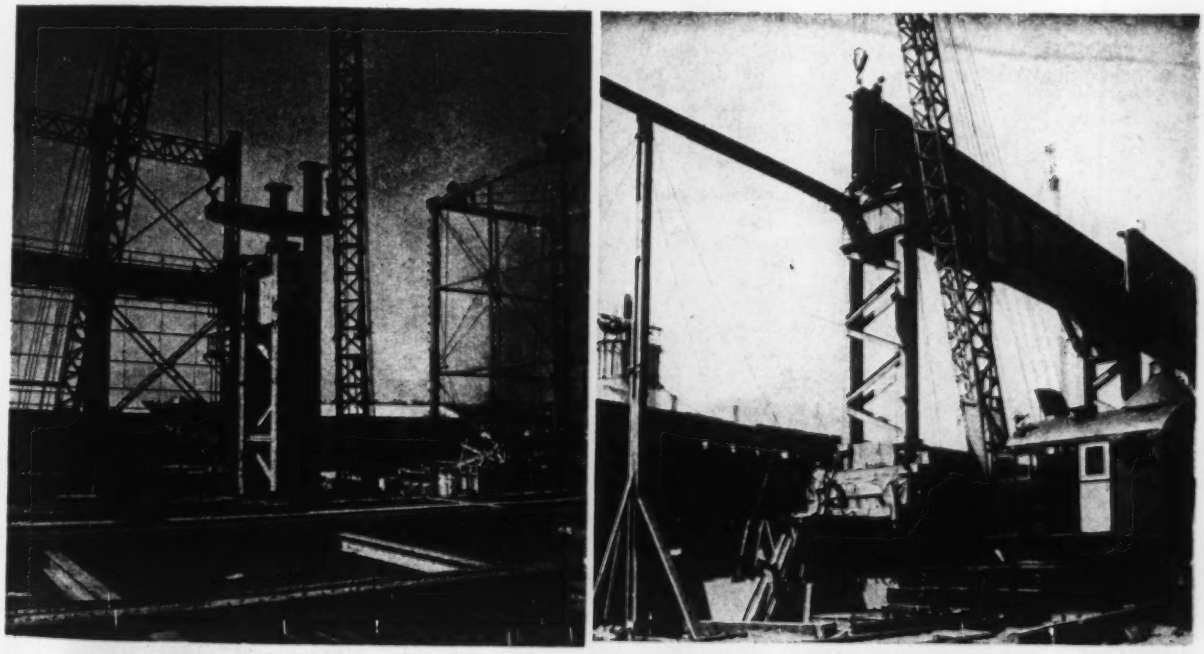


Fig. 2. Two 50-ton cranes erected the heavy open-hearth columns using a balance beam improvised from an old set of crane girders (left), while a steel grillage, sand box and temporary center column bent (right) aided in the erection of the half-sections of some of the 108-ton crane runway girders.

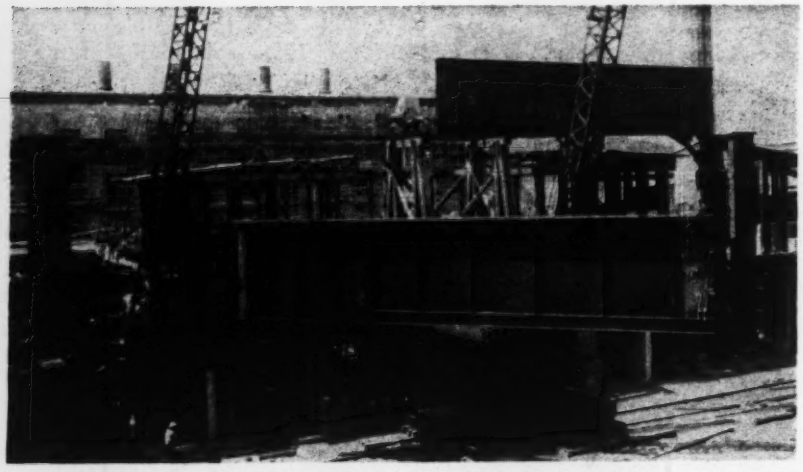


Fig. 3. Temporary timber-frame bents were used in the erection of some of the crane girders, each section of which weighed 54 tons.

of the span, and cross-braced to form a tower (Fig. 3). For the girder span over the tilting furnace, six short crane girders were placed horizontally on the concrete walls of the furnace, to form a grillage. On top of this grillage was placed a sand box which, in turn, supported a short column (Fig. 2—right) to complete the temporary bent at the center of the girder span.

Girder erection

The bottom coverplates, which weighed from 6½ to 9 tons, had to be set to camber and centered both ways before erecting the girder. Ends of the coverplate assembly were supported 1 in. below final camber by means of wood columns made of 3x9-in. timbers. After the two halves of a girder were erected the bottom coverplate assembly was bolted in place and drift-pinned. Then web and flange splice plates were bolted in place and pinned, and the assembled girder checked for proper camber. All rivets in the girder splice and in the bottom coverplates were driven before swinging the girder free of the falsework.

All sections of these heavy girders were transported to the job in an up-side-down position since their center of gravity was located near the top flange. This necessitated their being rotated 180 deg. before erection.

By using the temporary bents, the girders were raised with two 50-ton cranes each having a 90-ft. boom, although the equipment was worked right up to its allowable lifting capacity. Erection of the girders averaged only 72 tons per day due to the limiting working conditions under which it was executed.

All crane girders in the openhearth had to be placed before starting erection of the roof as there were struts above the girders and between the columns, each of which was 108 ft. long and weighed 16 tons. These struts came completely knocked-down as did all steel in the roof and frames, with the exception of some short girders. All steel was assembled in the mold yard, match-marked, and stored until erected.

Straightening gang kept busy

Unlike the erection of steel plants in this country where steel arriving at the site is rarely damaged, one of the most important operations was that of straightening and remarking steel that was bent and damaged in shipment. A straightening gang worked at this chore continually for eight months.

Since the furnace steel arrived ahead of the openhearth building steel, the furnaces were erected first in order to keep the project going. This increased the difficulty of placing of the charging floor and crane girders. The charging floor had quite a few 10 and 12-ton girders that had to be set with cranes working to a 72-ft. radius.

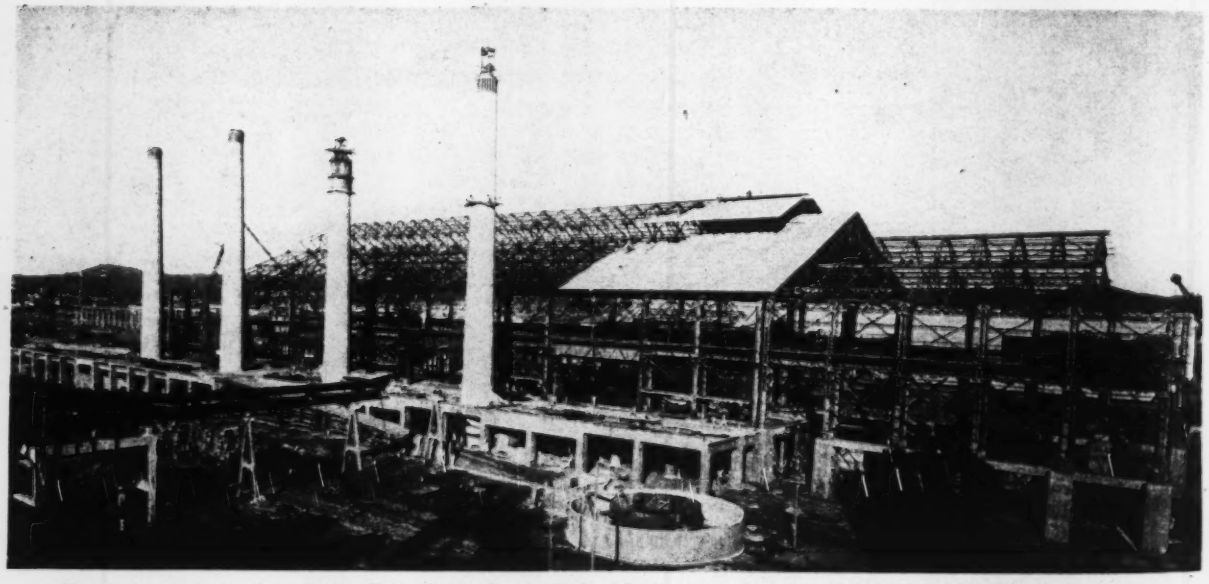


Fig. 4. Largest structure in the Volta Redonda steel plant is the open hearth, requiring over 15,000 tons of steel.

A delay in the delivery of the second-class brick for the furnace flues prevented placement of earth backfill, an operation that would have permitted the use of crawler cranes for erection of the charging floor. Consequently, the only alternative was to use a traveler. The traveler was needed particularly for erecting the openhearth roof since the ridge struts in the monitors were 127½ ft. above the charging floor.

Special traveler for roof trusses

The traveler consisted of a 60-ft. tower made of 14x14-in. timbers mounted on two 70-ton flat cars. The hoisting engine was mounted on one of the cars, both of which were ballasted with ingot molds. On top of the tower was mounted a 30-ton stiff-leg derrick having a 100-ft. boom. This rig had a lifting capacity of 16 tons at a 42-ft. radius.

About three-quarters of the charging floor was erected with the traveler, in addition to the trusses on the charging side and teeming side of the furnaces, the openhearth roof and the adjacent mixer building.

A remarkable record of safety was established on that part of the project with which the author was directly connected. There were no fatal accidents and a minimum of man-hours lost from minor accidents during the erection of 15,550 tons of steel in the openhearth division, plus an additional 8,500 tons of steel in the four soaking pits and overhead cranes. This speaks well for the capabilities of the Brazilian steel worker.

Much credit also is due Col. Macedo Soares E Silva, technical director of the entire project for his aid and assistance in expediting the work. [Col. Soares is now Minister for Communications and Public Works for Brazil—Editor]. In the performance of his duties, the author came in contact with 22 departments of the National Steel Co. of Brazil. With but few exceptions they always had the job well-planned and timed, but worked with a flexible program and accepted any changes that were necessary to expedite the work.

Last but certainly not least was the treatment received by the Americans in Volta Redonda. They had a hotel second to none in the United States, which was constructed for the sole purpose of accommodating personnel concerned with erecting and starting the plant. Although there were only eight homes under construction when the project was started 2½ years ago, besides a few temporary houses, today there are 1,400 homes, most of which are finished.

Fig. 5. Straightening structural members damaged in shipping kept one gang busy for eight months.

At this writing practically every American on the project has received without cost one of these homes fully furnished, including electric refrigerators. Transportation is furnished free to all Americans to expedite their work. Food conditions are above average and the very best of water is supplied by the company's own treatment plant.

Transportation between Rio de Janeiro and Volta Redonda has improved to such an extent during the past 2½ years that the old steam engines have been replaced with eight large diesels which has increased the number of cars per train to an average of 22. Tunnels are being widened, double tracks are being installed and within the very near future the Central Railroad of Brazil will be electrified between Volta Redonda and Rio de Janeiro.

Plant fabricated in this country

Major suppliers of engineering services and materials included: Bethlehem Steel Co., Pittsburgh, who furnished structural steel for the openhearth division, mold yard, stock yard, skull-cracker and calcining building; and the Arthur G. McKee Co., Cleveland, who built the 1,000-ton blast furnace, made the over-all design of the plant and supervised its construction.

The openhearth and mixer building was designed by Freyn Engineering Co., Chicago. Stacey Bros. Gas Construction Co. of Cincinnati built the two large gas holders. The coke oven, benzoil and tar plant were built by Koppers Co., Pittsburgh.

The soaking pits were designed by Rust Engineering Co., Pittsburgh, and the overhead cranes were built by Morgan Engineering Co., Alliance, Ohio, and the Cleveland Crane and Engineering Co., Wickliffe, Ohio. The blooming mill was furnished by Mesta Machine Co. and the United Engineering & Foundry Co., both of Pittsburgh.

Leighton F. Korb, formerly in charge of erection and operation of the Ford plant in England and a large steel plant in Turkey, was project manager at the start of the job. Since October 1944, he has been working directly as works manager and assistant technical director. Paulo Martins, Brazilian assistant to the technical director during the erection of the plant is now technical director of the new mill, succeeding Col. Soares.

A communication from Volta Redonda states that the boiler house of the completed mill is operating 24 hr. per day. The coke ovens were started in April, the blast furnace in May, and the openhearth operations in June. The blooming mill will be started as soon as steel ingots are available. Blooms and slabs will be stocked and the structural mill is expected to be in operation by September of this year.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Cooperative Pollution Control

Sir: The editorial in connection with H. R. 6024 (*ENR* June 13, vol. p. 904) seems to me to give too little weight to the current which runs all through the bill referring to "cooperation with other federal agencies, with state health authorities and interstate agencies and with the municipalities and industries involved." Other sections of the bill say, "to make joint investigations with such agencies," and "The Public Health Service, upon request of any state health authority or interstate agency."

In addition to the above, section 15 comments, "It is the policy of this act that the Public Health Service shall encourage interstate agencies, states, municipalities, and other public bodies to exercise their powers and authority to prevent and abate water pollution."

When the clear intent of the bill is to promote cooperation between the municipal, state and federal authorities, it is difficult to see how any court would construe an arbitrary and capricious enforcement as being within the authority of the Surgeon General.

It seems quite probable that any effort to make considerable modifications in the bill would merely result in no bill at all being passed and it does not seem that the state authorities are running any great risk in pressing for the passage of this bill (H. R. 6024).

ROBERT C. WHEELER
Barker & Wheeler
Albany, N. Y.

Joint Action in Canada

Sir: The news item headed "Doubt Ontario Engineers' Wage Status" on page 73 of your April 18 issue was only brought to the writer's attention a few days ago.

It will perhaps be of interest to your readers to learn that the many meetings held in Ottawa by a directive from all the nationally organized engineering and allied scientific societies in Canada were finally wound up by a majority vote which placed all further action in the hands of the Canadian Council of Professional Engineers and Scientists. This new liaison body is a council organized for all the presidents or their alternates of the nationally organized engineering and scientific bodies in Canada, to represent engineers and scientists on all matters of national interest.

Through this council, which has its headquarters in Ottawa, the professional engineers and scientists have for the first time, a common front and a common voice in the national scheme of things. It has been operating now for approximately a year and a half, and although still functioning in an experimental manner, the new council finds itself the largest professional body in Canada (approximately 25,000 combined membership) with tremendous potentialities for raising professional standards on the one hand and directing efforts for increased national efficiency on the other.

The Canadian Council of Professional Engineers and Scientists does not interfere or compete in any way with the work or policy of any of the existing societies. It functions as a clearing house and a national directive for any and all problems concerning policy of national character. The much discussed matter of the collective bargaining status of professional engineers and scientists employees is merely one of the many national problems being faced.

The council however has no mandate to merely push hard for some narrow selfish policy for either national glorification or pecuniary gain to its individual members. It will try instead to encourage factual thinking along the broadest possible lines, protecting engineers' and scientists' interests not exclusively for their benefit, but to improve their status and morale in strict keeping with their place and function in the community as a whole.

The men of science in every nation today are utilizing a lever which is increasing in length and being loaded with more and more civic responsibilities.

The Canadian Council of Professional Engineers and Scientists is organized for responsible and clear-thinking liaison with government in the belief that this is the greatest role still to be played by the combined professions.

W. J. GILSON
Vice Chairman,
Canadian Council of Professional Engineers and Scientists

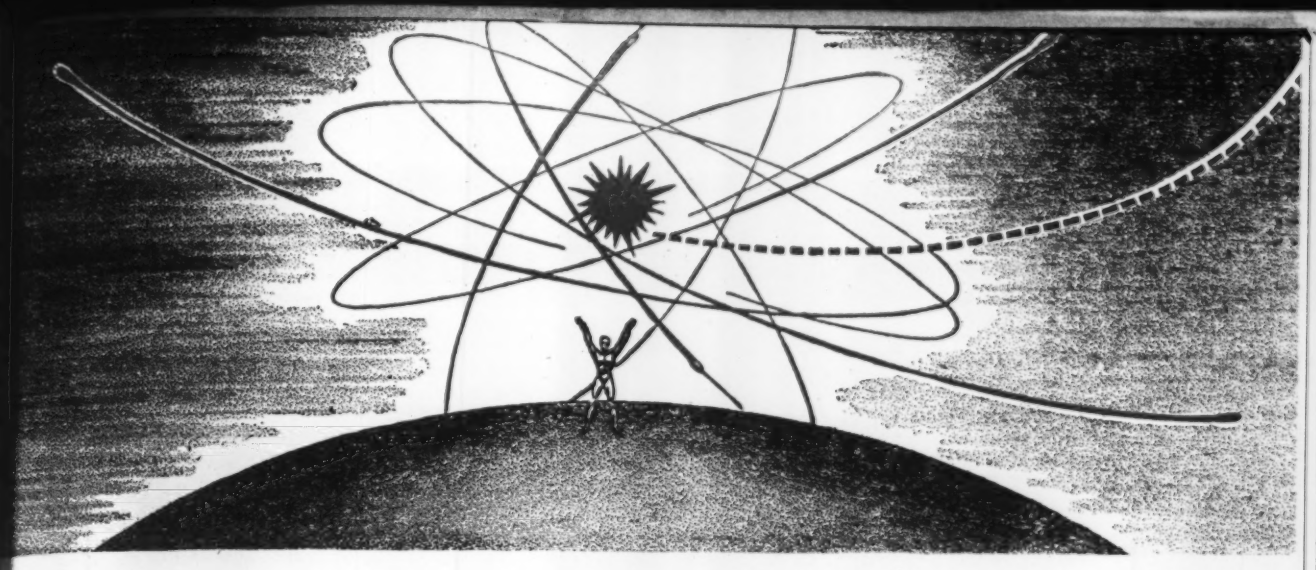
Civil Engineer Corps Officers

Several errors that need correction were committed in editing the biographical article titled "Navy's Civil Engineer Corps Reorganizes for Peace" (*ENR* May 9, 1946, vol. p. 750). First, the title was incorrect because the article related only to those Civil Engineer Corps officers attached to the Bureau of Yards and Docks in Washington and assigned to its top positions. Many other C.E.C. officers are on other assignments, including, for example, Admiral Ben Moreell and Rear Admiral Carl Cotter, in the Office of the Assistant Secretary of the Navy. The title should have read "Navy's Bureau of Yards and Docks Reorganizes for Peace".

Another revision needs to be made in the biography of Rear Admiral John J. Manning, chief of the bureau, who was reported as becoming head of the Atlantic Division of the Bureau of Yards and Docks in June, 1945. That was the date he ended the assignment and became Director of the Eastern Pacific Division. The date when he took over the Atlantic Division job was November, 1942, so that he actually served in this key post for nearly three years. Previously, from September, 1937, until November, 1942, he served as head of the fleet facilities division and as director of the construction department of the bureau in Washington.

A typographical slip also occurred in the substitution of a *J* for the middle initial of Rear Admiral Joseph F. Jelley, Jr., assistant chief of the bureau.

No errors in the other 15 biographies have been called to our attention. Naturally they omitted mention of many of the former assignments of the officers, careers of 20 years and more not being compressible into 2 inches of 9 pt. type. The real purpose of the article was to highlight the new peacetime jobs of men who had recently ended a brilliant wartime service.



MAN vs ATOM—YEAR 1

WHEREIN WE SIGNALIZE THE FIRST ANNIVERSARY OF THE ATOMIC AGE, CONSIDER THE ALTERNATIVES INHERENT IN BOTH GOOD AND EVIL POTENTIALITIES OF NUCLEAR FISSION, THEN VENTURE A GLIMPSE INTO THE FUTURE

A YEAR AGO, July 16, 1945, at Alamogordo, New Mexico, man created the first atomic explosion. Most impressive events diminish in stature as they recede in time. This one grows bigger with each passing day. It truly marked the beginning of a new age.

As Year 1 of the Atomic Age ends and Year 2 begins, we are engaged in three portentous projects.

At Bikini Atoll we are detonating the fourth and, possibly, the fifth atomic explosions in the history of the world.

At Oak Ridge, Tennessee, we are building the first atomic energy plant for peaceful purposes.

Most important, in New York we and all the other United Nations are engaged in the first attempt to subject atomic energy to international control. Literally, the fate of the world hangs on this attempt.

As this introduction is written, the United Nations Atomic Energy Commission has just begun its work. People everywhere pray for its success—for their own sake, but even more for their children and for their grandchildren. If this Commission fails let everyone everywhere be warned: the world has taken a step toward destruction.

As we enter the second year of the Atomic Age, the nations of the earth are embarked on an atomic armaments race. There is no blinking that fact. We have had official notice served on us. Therefore, we must understand that unless the United Nations Commission can arrest the drift of events, we are moving toward a horrible war. The Commission must succeed.

The American delegate, Mr. Baruch, has brought to the Commission an ably thought out plan. It would internationalize nuclear science, and release for mankind the beneficent applications of atomic energy. But it would "control" atomic bombs only to the extent of giving the world brief warning of any nation's preparation to use them, so that we might have foreknowledge of disaster.

Therefore, the real and enormous task before the world becomes clear. We must end war. No other control of atomic weapons exists. If war comes, atomic weapons will be used. If they are used, our children who survive will curse their fathers. Understanding the consequences of failure, we *must* succeed.

Because we cannot succeed without knowledge, I have asked my associates at McGraw-Hill to condense into the following pages what we know at the close of Year 1 about this great new atomic force — its basic science, its possible uses and its political repercussions.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

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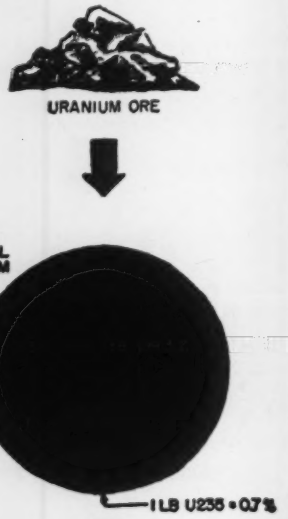
This Fateful Atom . . .

1 ORE TO U235

Only 0.7% of natural uranium is U235



LOOKING BACK twelve months to the birth of Year 1, Atomic Age, we begin to sense the majestic import of the atomic bomb that blasted the naked desert at Alamogordo, N. M., on July 16, 1945. There man first shattered atoms in an explosive *fast-chain* reaction. Then came Hiroshima and Nagasaki.

In every case the fateful atom was either uranium 235 (U235), or plutonium derived from the action of U235 on U238. Every pound of U235 atoms split in these unprecedented blasts yielded the energy of 11.4 million kilowatt-hours, or 1400 tons of coal — slightly more for plutonium.

No matter where one mines uranium ore, the purified natural uranium (Fig. 1) always contains 99.3% of the "garden" variety U238, and a mere 0.7% of the precious U235.

An atom is like our solar system. The central sun is the nucleus — a bunched mass of protons and neutrons, each weighing one unit. The planets are electrons. Each proton has one plus electrical charge — each electron an equal negative charge. There must be as many negative electron planets as positive protons in the nucleus. This is also the "number" of the atom. Neutrons have no charge, but add weight.

The atomic number of uranium is 92 because the uranium atom always has 92 nuclear protons and 92 electron planets. The isotopes U238 and U235 differ only in the number of neutrons; U238 has 146 neutrons, and weighs 92 + 146 = 238 units. U235 has 143 neutrons, and weighs 92 + 143 = 235 units.

Ordinary chemical reactions, such as TNT explosions, release only a fraction of the modest energy of the whirling electrons in the outer atom. Nuclear reactions unlock the immensely greater energies which bind together the nucleus.

Even the gentle tap of a slow-moving neutron bullet will split the atom of U235 or of man-made plutonium into two medium-weight atoms, yielding also one to three spare neutrons plus energy. Thus these *fissionable* materials supply both their own bullets and a highly sensitive lot of high-explosive targets — a perfect setup for a *chain reaction* (Fig. 2).

Chain reactions work like chain letters. Neutrons from one nuclear explosion hit and explode other nuclei. But, since atoms are mostly open spaces a chain started in a small block of U235 or plutonium quickly dies out because most of the released neutrons escape from the block.

The bigger the block, the smaller will be the percentage of escaping neutrons, and the more left to split other nuclei. When the block is rapidly built up beyond a certain secret size the fragments of 1000 nuclear fissions split many more than 1000 additional nuclei. Then fissions multiply geometrically, and the block disintegrates with explosive speed and violence — as in a bomb (Fig. 3).

This bomb explosion is a fast-neutron chain. For economy and ease of control, uranium piles for the gradual release of nuclear energy for commercial purposes will normally use a lean fuel — that is U235 or plutonium diluted with U238, thorium or other less costly materials.

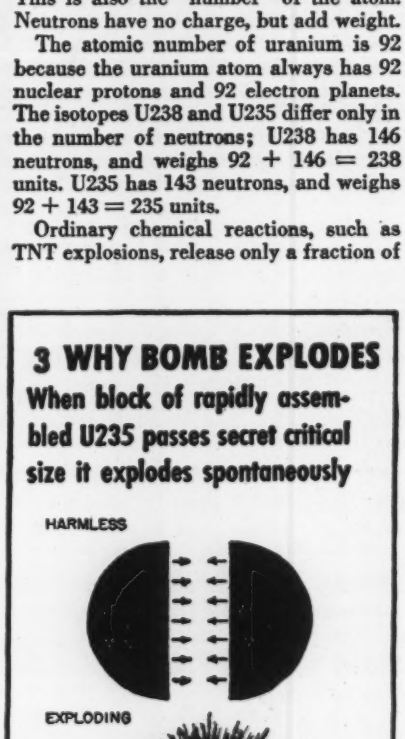
To maintain a chain reaction such piles must be large and artificially stimulated by using carbon blocks or some other *moderator* (Fig. 4) to slow many of the neutrons. Slow neutrons make more hits than fast neutrons because there is more time for them to be swerved from a straight path by the attraction of nearby nuclei, as shown below.

2 CHAIN REACTION

Fragments from earlier nuclear explosions smash other nuclei

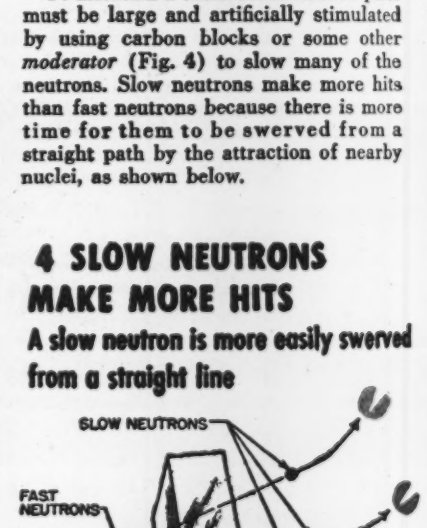
3 WHY BOMB EXPLODES

When block of rapidly assembled U235 passes secret critical size it explodes spontaneously



4 SLOW NEUTRONS MAKE MORE HITS

A slow neutron is more easily swerved from a straight line



...can Serve Man...

THE FATEFUL U235 ATOM can serve man as a new, compact source of heat energy for power generation, comfort heating or industrial processing. Peacetime applications of atomic energy will use dilute U235 or plutonium as a "fuel," mixed with carbon or some other moderator to slow some of the neutrons and thus keep the chain reaction going.

The diluting agent may be either U238 or thorium, or both. These will do double duty, because neutron bullets convert U238 into the energy-yielding plutonium, and thorium into U233, which may prove equally serviceable.

Thus the commercial piles of the future will "burn" U235 to make other atomic fuels, plutonium and possibly U233, which in turn will deliver heat energy to the pile. In that way it will be possible to get from the pile far more heat than the equivalent of 1400 tons of coal for each pound of U235 split. This highly attractive prospect will speed the day when nuclear energy can compete with coal.

While already mechanically obsolete, the piles making plutonium for bombs at Hanford, Wash. (Fig. 1) reveal the basic principle on which future piles for power and heat will operate. The heat now wasted in vast quantities will be put to work. The plutonium, now removed for bomb manufacture, will be returned to the pile (or left in) as supplementary fuel.

ATOMIC POWER

The possible everyday applications of nuclear heat pictured in Fig. 2 have been recognized from the very first day of the Atomic Age. Year 2 will see the building of the world's first atomic power plant (a pilot plant) at Oak Ridge, Tenn.

Beyond question such installations will produce power, but it may be years or decades before they prove economical. To compete with conventional plants the piles must first be redesigned to run at temperatures high enough for good power-plant efficiency. Also the techniques of operating piles by remote control through the heavy radiation screens must be radically streamlined.

The Hanford piles run on natural uranium containing only 0.7% of U235. The typical commercial atomic power plant of the future will use more than 0.7% of U235 or plutonium, but less than 50%. This will avoid both the low efficiency of the too-lean mixture and the excessive fuel cost of the rich mixture. It will permit piles of moderate size and take maximum advantage of U238 and thorium as potential sources of plutonium and U233.

One should not expect U235 to replace coal generally in this generation, although a few central power stations and ships will try it out before Year 10 of the Atomic Age. Plants far from traditional sources of fuels may turn much sooner to uranium and thorium as concentrated heat sources, that may easily be transported even to remote corners of the earth.

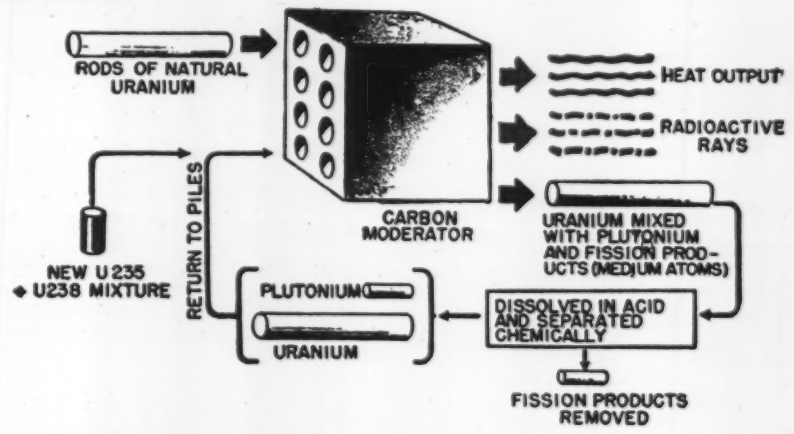
Atomic power, in forms now known, is impracticable for automobiles and small airplanes, because of the large initial investment in uranium and the need to carry 50 tons of shielding to protect riders and pedestrians against the deadly radioactivity accompanying nuclear fission.

RADIOACTIVE ISOTOPES

More immediately important than the heat and power applications of nuclear energy are the services that the radioactive byproducts of pile operation can render. Because these materials act chemically like their ordinary non-radioactive cousins, but can be followed and detected easily, they are expected to play tremendously vital parts in medicine and biology. For more details, see the last page of this section.

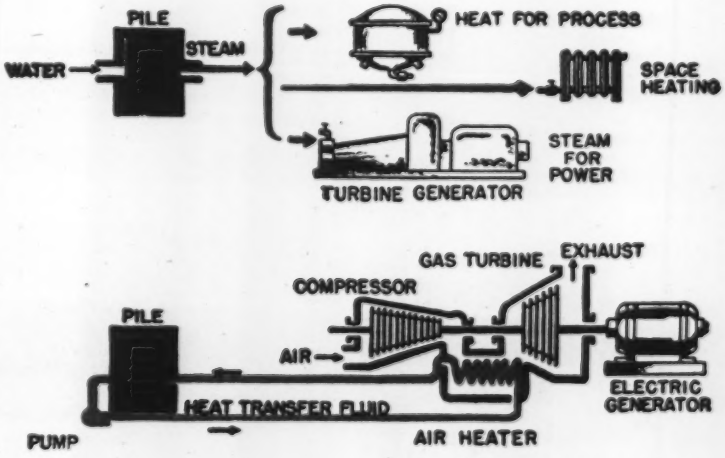
1 SLOW-NEUTRON PILE

Can make plutonium for bombs—or heat for power, process and comfort



2 PRACTICAL APPLICATIONS

Include steam for turbines, process and comfort heating—also heat for gas turbines



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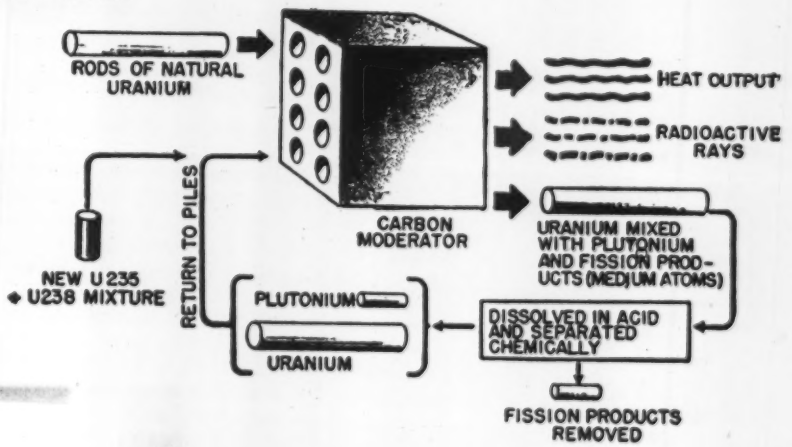

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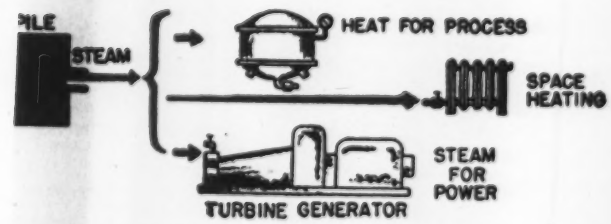
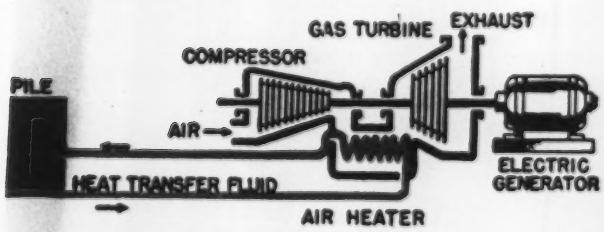




or Destroy him . . .

A single improved atomic bomb can devastate ten square miles of city

URANIUM 235 and plutonium are now man's slaves. They will build or destroy as he orders. Man dreads this vast force only because he distrusts himself. War is proof that man in the mass has never achieved self-control. He has always sought better weapons; yet the perfect weapon now brings him no satisfaction for he sees in the atom bomb his own destruction as well as that of his enemy.

The ultimate benefits of nuclear energy may well surpass its present terrors, but the terrors are here now in awful dimension, and man must face them. He must pay this price for unlocking the wealth of the inner atom.

ATOMIC BOMB

This page, then, is about the atomic bomb. Nothing will be said here that is not either a certified scientific fact or a conclusion shared by the majority of the leading scientists, engineers and statesmen who have studied the matter.

As already explained, an explosive nuclear chain reaction spontaneously sweeps through a block of U235 or plutonium when the block is rapidly enlarged beyond a certain "critical" weight X. That weight is still a military secret; the official Smyth report vaguely suggests that it is more than 4 lb and less than 200 lb. Each piece of U235 in the dormant bomb must weigh less than X. At the desired instant of explosion the bomb mechanism assembles these pieces rapidly into a single piece considerably heavier than X.

The explosion itself drives the U235 pieces apart, thereby quenching the atomic conflagration before all the atoms are split, so the bomb efficiency is far less than 100%. For each pound of U235 (or plutonium) atoms actually split, the bomb releases the energy of 1400 tons of coal.

This explosion is mainly ordinary heat at work in unprecedented concentration. Bomb metals become incandescent vapor millions of degrees hot. This, and the enveloping sphere of glowing air, radiate a blinding flash that chars human flesh at half a mile and blisters at over a mile. There is a destructive shock wave (sound) and a second-long hurricane of unimaginable force — the outrushing of the expanding heated air. Deadly neutrons and gamma rays speed out from the bomb.

A single atomic bomb killed about 100,000 at Hiroshima. Fewer died at Nagasaki only because the circle of potential destruction included much vacant land. Bombs ten times more powerful can be made by the thousands in any major industrial country with the plants and the know-how. One bomb could saturate Minneapolis or downtown Manhattan.

Many experts estimate that a complete set of American atomic "secrets" and blueprints might save a foreign power two to three years at best in its race for atomic arms. With no help at all from us, any advanced industrial nation can, in five to ten years, acquire the raw materials, the plants, the know-how and enough bombs to knock out the big cities of any other country overnight. In Year 2 of the Atomic Age this arms race is already on.

It will not fail for lack of raw materials; every country has lean ores worth working for bombs.

THE CHEAPEST DEATH

Cost need not deter, for the atomic bomb is by far the cheapest method of destruction ever devised. General H. H. Arnold estimates that atomic bombs can be manufactured *and delivered* for less than $500,000 per square mile of destruction.

Don't be misled by the two billion dollars America spent on a project that dropped only two bombs on the enemy. New plants can be built at a fraction of wartime cost, and the investment spread over thousands of bombs, not just two.

There is no known defense against the atomic rocket attacking at mile-per-second speed

NO DEFENSE

So the bombs can be made in ample quantity and paid for, but can they be delivered? The answer is: "Yes; by the time the bombs are ready they can be delivered anywhere and overnight." If the defenses of the target country are weak, piloted planes can get through in ample number. Ten percent would be enough.

For more effective delivery radio-steered pilotless planes and rockets can carry the atom bombs faster than sound. Such weapons will be almost untouchable by either antiaircraft artillery or manflown fighters.

Greatest threat of all will be the transoceanic rockets. The German V-2 rocket, which never once was stopped by Britain's defenders, points one way. It needs only transatlantic range (with atomic propulsion) and an atomic bomb in the nose. Forty-six feet long, loaded with 7500 lb of alcohol fuel and 11,000 lb of liquid oxygen, the V-2 of World War II rose 60 miles in the air and arced 200 miles in five minutes to deposit one ton of TNT in London.

Seeing so many strange things come to pass, the man in the street cannot distinguish between possible miracles and the impossible variety. From the very start of the Atomic Age he has been hoping for a "ray" that will explode the atom bomb far off. Competent scientists and engineers say that cannot be.

The only way to bring down a 3500-mile-per-hour rocket at a safe distance is to chase it with your own 4000-mph rocket. You can't win at this game often enough to establish ironclad protection.

The only specific defense against the atomic rocket known in Year 2 of the Atomic Age is to disperse all cities and put key industries underground. This would be very costly in time, money and national morale.

MORE AND BETTER BOMBS?

Some will ask whether the U.S., as the most powerful industrial nation, could not build more and better bombs and carriers than any other nation. Probably yes, but there is still no real security. If the "weak" opponent has enough atomic weapons to destroy us once, what advantage is there in being able to destroy him twice?

Shooting first could protect us now, but not after the world is atomically armed. If we were to destroy the enemy's cities, we would probably miss his well-concealed and protected bomb magazines and rocket launchers. A few minutes later he could return the atomic fire. In brutal simplicity, that is the picture of future atomic war. Everybody loses.

At this point one grasps at another straw: "If everybody is to lose who would be so foolish as to start an atomic war? And didn't the Germans refrain from using gas for a similar reason?" Possibly yes. It *may* work that way. But in a world atomically armed to the teeth some nervous finger *may* pull the fatal trigger.

ONLY ONE WAY OUT

Throughout history each new offensive weapon has called out its appropriate defense. But now the offense leaps centuries ahead in a single bound and the defense lies almost helpless everywhere, unless some technical protection, unknown as Year 2 begins, can be devised.

The situation is extremely dangerous. There is no clear way out except through some sort of international action first to stop the atomic arms race and, before it is too late, to hobble war itself.

Can it be done? Perhaps not, but there is no alternative except atomic chaos.

...so he faces the Atomic Dilemma.

THE NUMBERED statements that follow in somewhat logical pattern are too fateful to be accepted on anybody's say-so. Every reader should test them in the light of his own information and understanding.

The points below sum up the conclusions of the previous article — and these in turn reflect a great mass of thought and discussion among leading scientists, engineers and statesmen close to the problem. To an amazing degree they concur on both facts and conclusions. For authoritative statements of their line of thought, in detail not possible here, the reader should see the recent book, *One World or None.*

THE DILEMMA

Nations must either face the probability of an atomic World War III, which would surely be the most deadly in history . . .

***Or,* the experts propose, yield both atomic weapons and war potential to international authority backed by superior force.**

What the Experts Say

1. In five to ten years any major industrial nation can make enough atom bombs to destroy all the major cities of any other country overnight.

2. This assumes no "secret" information or other help from us.

3. The necessary uranium ores will be at hand.

4. The cost will not be too high.

5. The bombs produced can then be carried thousands of miles by bombers, or by atomically powered guided missiles moving faster than sound.

6. There will probably be no effective military defense against such weapons.

7. Dispersing cities, and putting key industries deep underground, will give some protection if accomplished in time, but at incredible cost in money and human discomfort.

8. In a world atomically armed, nations can probably protect their bomb stocks and rocket launchers from enemy assault.

9. If so, nation A can destroy the cities of any other nation B, after which B's rockets will destroy the cities of A. Shooting first will not win an atomic war.

10. This knowledge may not restrain the trigger finger of a suspicious power.

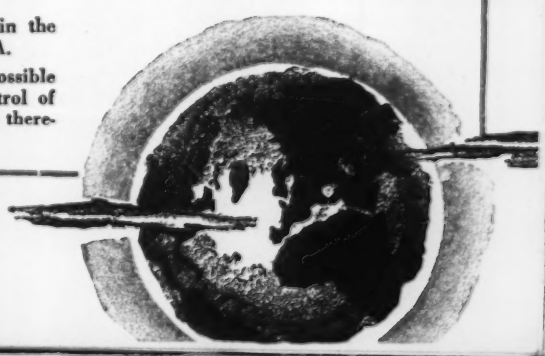
11. Having more and better atomic weapons than the other fellow won't help much if he has enough to destroy us. No use to kill a man twice or rebomb urban ruins.

12. Every nation is vulnerable in the Atomic Age, including the U. S. A.

13. National security will be impossible without (first) international control of atomic arms and (not too long thereafter) international control of all war potential, both backed by superior physical power.

14. If action to this end is long delayed, it may become impossible to halt the atomic arms race already started.

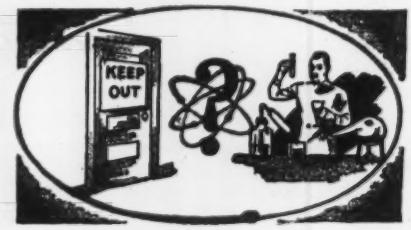
15. At best, the necessary degree of international control, with some real delegation of national sovereignty, will be a revolution in human affairs. It may prove to be humanly unobtainable at this time. If so, men and women everywhere must face the probability of an atomic third world war—by far the most destructive in all history.



In this atomic age no nation can be safe through its own unaided might

...and the Great Debate unfolds

ATOM YEAR 1 has probably been marked by more debate on a single subject than any other twelve months in the world's history. Social, economic and political as well as purely technical issues have been pressing for realistic solution. Let us look at these issues and see where we stand:



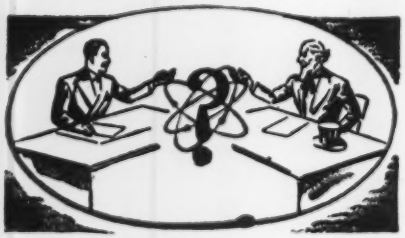
SECRECY VS. FREE SCIENCE

Throughout the first year of the Atomic Age hot debate has raged around "keeping the secret of the bomb." To prevent potential enemies from making atom bombs some have urged a complete blackout of all phases of atomic energy — even of the scientific fundamentals of nuclear physics. Others have sought immediate and complete disclosure of all bomb "secrets," both scientific and technological. These have held that such information cannot be effectively hidden, that secrecy blocks progress and breeds wars.

A year of debate has brought the great mass of vocal opinion to this middle ground: (1) Ease restrictions on the exchange of basic physical knowledge. (2) Release for industry's benefit many of the devices and methods developed for the bomb project. (3) Hold tight to specialized information on atomic bombs and bomb-material production until international safeguards are fully operative.

CIVILIAN VS. MILITARY

Because the atomic bomb is the world's greatest weapon, the armed forces would like to control it. But because atomic energy can also be used for peaceful, beneficial purposes, civilian control seems equally essential. These conflicting viewpoints had their strong proponents before the Congress which finally reached a fairly satisfactory compromise in the Atomic Energy Bill of 1946, setting up a competent civil board with which the armed forces will have continuing liaison. As we go to press, just before Year 2 of the Atomic Age begins, this bill has passed the Senate, but there is still a question how rapidly it will be enacted into law.



PRIVATE VS. PUBLIC

Atomic energy is "too big" and "too hot" to be handled privately. It must be nationalized and internationalized. The questions are *how* and *to what extent.* Fortunately, as the "boxes" on these pages show, there are means that may attain reasonable safety against misuse of the atom, and still do so without public control of many "non-dangerous" applications.

DOMESTIC CONTROL AS PLANNED IN THE ATOMIC ENERGY BILL OF 1946

McMahon Committee Bill contains the following provisions.

Policy. Declares it the policy of the U. S. to develop and utilize atomic energy to improve the public welfare, increase living standards, strengthen competitive enterprise and promote world peace.

Organization. Establishes the Atomic Energy Commission (AEC) of five administrators to direct four divisions on research, production, engineering, and military applications—to work in liaison with three committees from (1) the armed forces, (2) outstanding civilians, and (3) joint Congressional representatives.

Production. AEC to own and operate (under management contracts with industry if deemed desirable) all facilities for the production of fissionable materials, such products to be distributed with their radioactive byproducts under license for private industrial and medical research.

Military Application. AEC to engage in development work and produce atomic bombs as directed by the President, to be delivered only on his order to the Armed Forces.

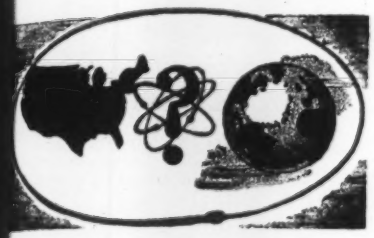
Industrial Utilization. Permits AEC to conduct research, design and manufacture equipment for atomic-energy utilization, license its use, produce and sell power obtained as a byproduct in the production of fissionable materials. Directs AEC to give widest safe scope to private initiative.

Control of Information. AEC to enforce a ban on the dissemination of restricted data that might be used to injure the U. S. or secure advantage to a foreign nation, yet to provide leeway for ultimately relaxing restrictions as future conditions warrant.

Patents and Inventions. No private patents permitted for production of fissionable materials or their utilization for military weapons, but AEC will justly compensate for such inventions, when made by private citizens. Patents for non-military applications may be purchased or condemned by the AEC only when public interest is affected.

Appropriations. "Such sums as may be necessary and appropriate to carry out the purposes and provisions of the act" *plus* unexpended funds of the Manhattan Engineer District.

while Time runs out



NATIONAL VS. INTERNATIONAL

Born of nationalism, the Atomic Age began when three nations discovered a weapon that today gives them the greatest military power on earth. The prime question is: Shall the atom remain the servant of its conqueror, nationalism?

During Year 1 of the Atomic Age the Truman-Atlee-King declaration, the masterly report of the State Department's atomic consultants, and the U.S. representative on the United Nations Atomic Energy Commission, have all called for international control of atomic energy. Year 2 will start with no such control. This failure to decide and act is in part a natural result of the extreme difficulty of the problem and the obvious dangers of unwise decisions. Nations everywhere face a triple dilemma in this Atomic Year 2: the dangers of nationalism, the dangers of internationalism, the supreme danger of not being able to make any decision in time to meet the atomic bomb threat.

INTERNATIONAL CONTROL AS PROPOSED BY THE U. S. TO U. N. ATOMIC COMMISSION

Baruch statement follows constructive path laid out by Atomic Consultants in "Acheson-Lilienthal Report."

The Plan. The U. S. has proposed that all nations band together to outlaw the use of atomic energy for war and to promote and harness its development for the benefit of mankind. To this end an International Atomic Development Authority would be set up, and to it the U. S. would turn over, at various stages of its organization, all atomic bombs, know-how, raw materials, facilities, and stockpiles of fissionable material. Thus IADA eventually would supersede national authorities on some matters and supplement them on others.

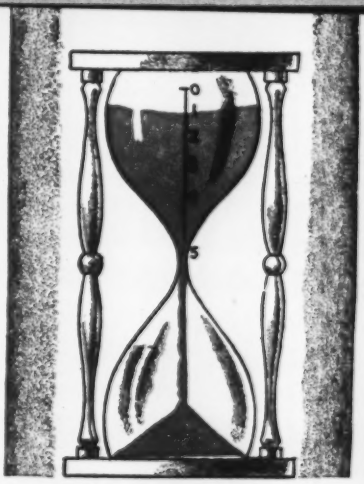
Owner and Operator. IADA would take over from national authorities or private ownership full management and control of all atomic energy matters that afford a possible threat to World security. These include:

1. Raw Materials—Supplies of uranium and thorium to be inventoried, controlled, and developed by IADA.
2. Facilities—IADA to control and operate plants producing fissionable materials and to own and control their products.
3. Research—IADA to undertake research and development on all aspects of atomic energy and to possess exclusive right of research on atomic explosives.

Private Initiative. Will have its chance to push forward the use of atomic energy for peacetime (non-dangerous) purposes. With IADA providing raw materials and carrying out necessary inspection, national and private enterprise may operate "safe" power piles, and produce and use radioactive isotopes for research, clinical and other applications. Radioactive isotopes produced by IADA also can be distributed for peacetime use.

The Mechanics of Safety. No plan is a certain guarantee against future atomic war. This plan should, however, prevent surprise attack with atomic weapons; for IADA is to buttress positive ownership or management controls with wide powers of inspection. Obviously, successful inspection rests on complete freedom of access or egress in any area.

Sanctions. At the heart of the plan lies the problem of penalty for violation — a matter for profound statecraft. To the U. S., one aspect of sanctions appears crystal clear: Here is an area where the veto right now held by the five great Powers must be redefined if it is not to be incompatible with the meaning and purpose of the proposed control.



Leading industrial nations can produce atomic bombs in five years, competent scientists announced after Hiroshima. Already one year of the precious five has been consumed in debate without international action. Soon it may be too late to check the growing momentum of the atomic arms race.

TIMETABLE—ATOM YEAR 1

1. July 16, 1945. World's first atomic bomb detonated in New Mexico.
2. July 26, 1945. President Truman and Prime Minister Churchill issue Potsdam ultimatum threatening Japan's destruction if she continues.
3. August 6, 1945. Atomic bomb dropped on Hiroshima.
4. August 9, 1945. Atomic bomb hits Nagasaki.
5. August 11, 1945. Army releases Smyth Report on "Atomic Energy for Military Purposes."
6. August 14, 1945. Japan accepts terms of Potsdam declaration.
7. November 15, 1945. Truman-Atlee-King issue declaration of intention and procedures looking toward international control of atomic energy by United Nations.
8. March 28, 1946. State Department issues Acheson-Lilienthal Report on the "International Control of Atomic Energy."
9. April 12, 1946. Manhattan Engineer District announces program for experimental development of atomic power.
10. June 1, 1946. "Atomic Energy Bill of 1946" passes Senate unanimously, is referred to House of Representatives.
11. June 14, 1946. First meeting of United Nations Atomic Energy Commission (Bernard Baruch as American member). Manhattan District announces availability of radioactive isotopes for research use.
12. July 1946. Joint Army-Navy tests of atomic bombs at Bikini.

...but if Man Masters Atom.

IF MUTUAL DESTRUCTION by the atomic bomb can be avoided, the first century of the atomic age will bring immense advances in scientific knowledge, health and living standards. Already many prospective benefits can be outlined, but those we can neither foresee nor suspect may be even more important.

This prediction is grounded in scientific experience; the most fundamental discoveries have always been the most fruitful. The study of molecules gave us chemistry. Faraday's experiments with electricity and magnetism are the foundation stones of the great electrical industry. Can one expect any less from an understanding of the heart of every atom?

BENEFITS

Atom-splitting benefits clearly visible today fall mainly in three classes: (1) heat and power applications of the uranium piles; (2) general industrial applications of equipment and methods originally developed for the bomb project; (3) chemical, biological and medical uses of the "tagged atoms" (radioactive isotopes) now abundantly available from pile operation.

It is now evident that the energy yield of the U235 in an atomic pile can be multiplied many times by returning to (or leaving in) the pile the plutonium and possibly the U233 produced respectively from the U238 and the thorium in the pile. This is an indirect way to "burn" inexpensive U238 and thorium, and thus greatly extend the supply and reduce the cost of atomic fuels.

POWER APPLICATIONS

Although present piles run at low temperatures, it is certain that temperatures high enough for the efficient operation of steam and gas turbines will be attained. Already an experimental atomic power plant has been ordered. Atomic power for certain remote installations (say, for heating Arctic airports) may not be far off.

In five or ten years uranium piles will be driving a few experimental ships and submarines. In 20 or 30 years uranium may begin to compete widely with coal as a fuel for suitably situated large central heating and power plants. The 50-ton minimum weight of shielding rules out nuclear power for automobiles and small piloted planes.

SPECIAL USES

Some day ultra-high temperatures from splitting atoms will be used for special industrial operations on metals and other materials. Even the dread atomic bomb might easily serve peaceful ends — blasting lakes in deserts, changing the course of rivers, leveling mountains.

INDUSTRIAL BYPRODUCTS

The special industrial equipment and methods developed for the bomb project will find hundreds of important uses — mostly for purposes unrelated to atomic energy. These developments include pumps with neither seals nor leaks, leak detectors of amazing sensitivity, ultratight welding, a portable mass spectograph for quick and automatic gas analysis, new ways of handling corrosive and poisonous materials, new diffusion barriers for the separation of gases and of petroleum products.

TAGGED ATOMS

Yet more important than any of these, in the long run, will be the hundreds of radioactive isotopes now available as by-products of pile operation. Chemically indistinguishable from the ordinary forms of the elements, these isotopes serve as tagged atoms or "spies" if mixed with common stable atoms of the same species. They "fly with the flock," and can later be identified as surely as banded birds. With these amazing tools of research, the course of any element or compound may be traced through the bodies of men, animals and plants. Similarly, tagged atoms may be used in studying the course of many kinds of industrial and chemical operations.

BIOLOGY AND MEDICINE

A suspected hyperthyroid condition can be diagnosed by feeding the patient a minute measured amount of radioactive iodine. The click of a "Geiger" counter placed on the patient's neck will tell (1) what percentage of the swallowed iodine concentrates in the thyroid cells and (2) how rapidly that concentration is accomplished — giving a definite indication of the state of the gland.

In similar fashion the radioactive isotopes of hydrogen, oxygen and carbon will trace out the intricate transformations of carbohydrates and proteins in the human body. Radioactive phosphorus will explore the bones. Radioactive iron will show how and where blood cells are formed. Radioactive sodium will time the circulation of blood.

USES IN INDUSTRY

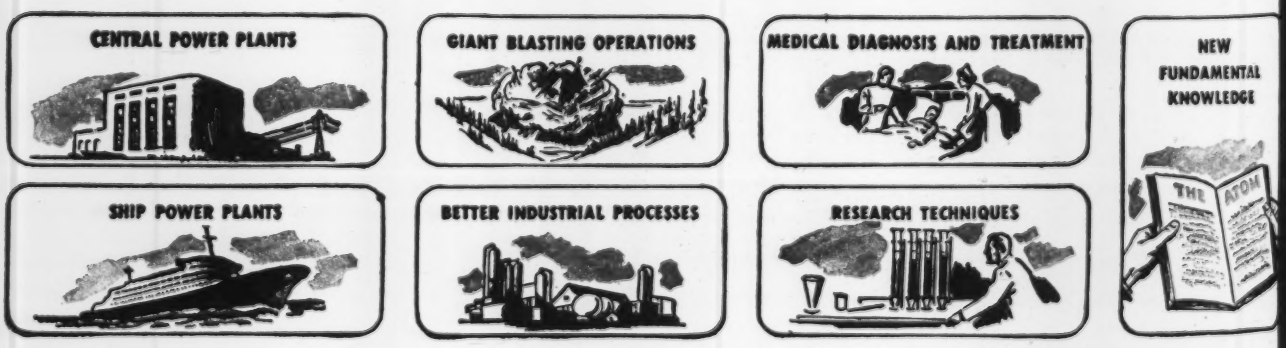
In chemistry the radioactive isotopes will speed the understanding of metallurgical and organic reactions. In industry they will measure flow, detect leaks, and do other useful work.

Meanwhile the uranium piles will be manufacturing certain radioactive isotopes that can serve as cheap but effective substitutes for high-cost medical radium.

KNOWLEDGE COMES FIRST

It is already clear that the chief benefits of atom splitting will come first as new scientific knowledge rather than as new engines and gadgets. But in the long run man's new understanding of the inner atom will enrich the whole range of human activity. This has always been the case with less fundamental discoveries in science. It can hardly be less with this most fundamental discovery.

ATOM SPLITTING WILL SERVE MAN IN:



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SHELL DIESEL FUELS

UNIT PRICES BID BY CONTRACTORS

Allatoona Dam and Powerhouse, Georgia

OWNER: U. S. Engineer Office, Mobile 7, Ala., Col. Mark M. Boatner, Jr., Dist. Engr., John S. Webster, Res. Engr.

PROJECT: Construction of flood control dam on Etowah River, in Barton County, Georgia approximately 25 mi. upstream from Rome, 5 mi. east of Cartersville and 35 mi. northwest of Atlanta, Ga. A concrete structure, 184 ft. high, 400 ft. wide at base and 1,020 ft. long. It will regulate floods on the Etowah River, provide 66,000 kw of electric power and create a 20,000 acre lake.

CONDITIONS: The work to be performed includes the following principal features:

(a) Construction of access highway from U. S. Highway No. 41 to the dam site, construction of connecting road on right bank and temporary buildings including the Government field laboratory.

(b) Cofferdams for the control of the river including their construction and removal.

(c) Foundation preparation for dam and powerhouse including clearing, grubbing, excavating, drilling and grouting.

(d) Concrete masonry for the dam, stilling basin, spray walls, training walls, retaining walls, powerhouse and switchyard.

(e) The transportation from Cartersville, Georgia to the site of the work and installation of equipment supplied by the Government including turbines, governors, transformers, switching equipment, switchboards, head gates, Tainter gates, cranes and other equipment for the dam and powerhouse as specified and the transportation of the generators from Cartersville, Georgia to the site of the work.

(f) Furnishing and installation of the penstocks and all materials, equipment and machinery and auxiliary apparatus required to construct the dam and powerhouse complete and in good working order.

(g) The grading of hillsides to safe and permanent slopes. Work is to start within 30 days of notice to proceed. Complete concreting of dam (spillway and non-over flow section) to elev. 850 including temporary installation of penstock intake gate hoists, 865 calendar days ($250 per calendar day penalty); complete concreting of powerhouse including permanent installation of mechanical and electrical equipment except generators, for 1st 40,000 KVA, 888 calendar days ($250 per calendar day penalty); complete construction of powerhouse and installation of mechanical and electrical equipment except generators for second 40,000 KVA within 1,070 calendar days ($200 per calendar day penalty); complete entire project within 1170 calendar days ($100 per calendar day penalty).

Transportation facilities include railroad at Cartersville, 5 miles due west, a junction point of Nashville, Chattanooga and St. Louis R. R., Louisville and Nashville R. R. and Seaboard R. R. Cartersville is also on U. S. Highway No. 41 and U. S. No. 411, first class hard surfaced roads and secondary road No. 41 on north bank of Etowah River which passes through dam site but is submerged during high water. Access road is to be constructed as part of contract.

Minimum Wages range from a top for plumbers, steam fitters, bricklayers and stone masons of $1.75, structural iron workers and electricians, $1.65, carpenters, $1.375, power equipment operators, $1.60 to $0.90, to unskilled laborers, $0.65.

BIDS: Bids were taken April 16, 1946 on four alternates. Contract awarded, April 29, on alternate 2 to the low of five bidders at $13,282,088, 8.6 percent above the government estimate. The high bid was $17,806,585.39.

LIST OF BIDDERS: Alternate 2

1. National Constructors, Inc., Columbus, Ga., owned and operated by the Arundel Corp., Baltimore, Md., L. E. Dixon Co., Los Angeles, Calif., & Hardaway Contg. Co., Columbus, Ga. (Contract) $13,282,088.00
2. Grannis, Thompson & Street Co., Charlotte, N. C. a joint venture of E. W. Grannis Co., Fayetteville, N. C., F. N. Thompson, Individual, Charlotte, N. C. and McDevitt & Street Co., Charlotte, N. C. 14,322,207.44
3. Walsh Constr. Co., New York, N. Y., Morrison-Knudsen Co., Inc., New York, N. Y., Bates & Rogers Constr. Corp., Chicago, Ill., B. Perini & Sons, Inc., Framingham, Mass., Henry J. Kaiser Co., Oakland, Calif., and Kaiser Co., Oakland, Calif., acting as joint contractors 14,599,902.00
4. Foley Bros., Inc., Pleasantville, N. Y., Johnson Drake & Piper, Inc., New York, N. Y., and Mason & Hanger Co., New York, N. Y. 15,930,824.20
5. J. A. Jones Constr. Co., Charlotte, N. C., and Wright Contrg. Co., Columbus, Ga., acting as joint contractors and co-adventurers 17,806,585.39

Government Estimate 12,232,136.74

	Item	Quantity	Government Estimate	Unit Prices (1)	(2)
1.	Cofferdams	570 lin. ft.	$789.00	$1,500.00	$946.46
2.	Excavation, common	134,300 cu. yd.	.60	3.00	1.00
4.	Excavation, rock	572,800 cu. yd.	2.55	3.00	3.00
5.	Foundation preparation	200,000 sq. ft.	.21	1.00	.40
6.	Press. grtg., consolidation, cmt.	9,000 sack	1.75	3.50	2.00
7.	Press. grtg., curtain, cmt.	9,000 sack	1.75	3.50	2.00
8a.	Drilling 1½" grt. holes, consol. grouting, 1st stage	2,500 lin. ft.	2.70	2.50	2.93
8b.	Drilling 1½" grt. holes, consol. grouting, 2nd stage	4,100 lin. ft.	3.10	2.50	3.22
8c.	Drilling 1½" grt. holes, consol. grouting, 3rd and succeeding stages	1,000 lin. ft.	3.98	2.50	3.39
9a.	Drilling 1½" grt. holes, curt. grouting, 1st stage	5,000 lin. ft.	3.13	2.50	2.99
9b.	Drilling 1½" grt. holes, curt. grouting, 2nd stage	6,500 lin. ft.	3.80	2.50	3.29
9c.	Drilling 1½" grt. holes, curt. grouting, 3rd and succeeding stages.	6,500 lin. ft.	4.85	2.50	3.39
10.	Foundation drains, 5 inch	15,000 lin. ft.	5.25	6.00	9.58
11.	6" steel pipe stubs	560 lin. ft.	3.47	10.00	1.81
12.	6" C I screw caps	210 each	2.75	2.00	1.71
13.	3" black steel grout pipe	3,250 lin. ft.	.60	1.00	1.22
14.	3" C I screw caps	210 each	1.95	.50	1.01
15.	Anchorage holes, 3-inch	5,000 lin. ft.	1.13	1.00	1.35
16.	Random backfill	21,800 cu. yd.	.87	.60	1.50
17.	Dumped rock backfill	48,250 cu. yd.	.93	.60	2.00
18.	Hand-placed riprap	970 cu. yd.	3.75	10.00	12.00
19.	Dumped riprap	4,480 cu. yd.	1.90	3.00	5.00
20.	Crushed rock	3,060 cu. yd.	3.45	6.00	8.88
21.	C I inlets, gratings, manhole frames and covers	39,250 lb.	.24	.14	.29
22.	6" concr. bell & spigot pipe	1,250 lin. ft.	1.50	1.00	1.07
23.	4" concr. bell & spigot pipe	1,600 lin. ft.	.80	1.00	.94
24a.	Non-reinf. concr. pipe—12"	710 lin. ft.	1.40	1.70	1.76
24b.	Concr. pipe, reinf.—18"	672 lin. ft.	2.45	3.30	3.38
24c.	Concr. pipe, reinf.—24"	375 lin. ft.	4.40	5.00	5.06
24d.	Concr. pipe, reinf.—30"	85 lin. ft.	7.00	8.00	12.85
24e.	Concr. pipe, reinf.—54"	246 lin. ft.	16.00	18.00	20.00
24f.	Concr. pipe, reinf.—60"	288 lin. ft.	19.00	20.00	22.00
25a.	Standard culvert pipe—18"	300 lin. ft.	3.05	2.20	2.97
25b.	Standard culvert pipe—21"	81 lin. ft.	3.60	2.50	4.06
25c.	Standard culvert pipe—24"	282 lin. ft.	3.90	3.40	5.45
25d.	Standard culvert pipe—30"	340 lin. ft.	5.10	4.40	8.28
25e.	Standard culvert pipe—36"	457 lin. ft.	6.85	6.50	10.00
25f.	Standard culvert pipe—48"	78 lin. ft.	8.85	8.50	15.69
26.	24" ½-rd. vit. clay dr. pipe	1,450 lin. ft.	3.50	4.00	5.22
27.	Press. deposited cmt. mortar finish	1,600 sq. ft.	.63	1.00	1.54
28.	Alter. #1, cmt., Portland in concr.	500,000 bbl.	2.80	2.30	3.30
29.	Alter. #2, cmt., Portland in concr.	400,000 bbl.	2.80	2.30	3.30
30.	Alter. #2, cmt., slag in concr.	100,000 bbl.	2.50	2.20	3.25
31.	Concrete, class A	26,600 cu. yd.	36.00	28.00	43.58
32.	Concrete, class B	82,250 cu. yd.	15.50	13.75	14.42
33.	Concrete, class C	408,600 cu. yd.	7.75	9.75	9.72
34.	Reinforcing steel	5,411,800 lb.	.08	.08	.078
35.	Wire mesh reinforcing	9,500 lb.	.14	.13	.15
36.	Copper stops	6,000 lb.	.82	1.00	.97

(*Continued on following page*)

Allatoona Dam and Powerhouse, Ga.

(Continued from preceding page)

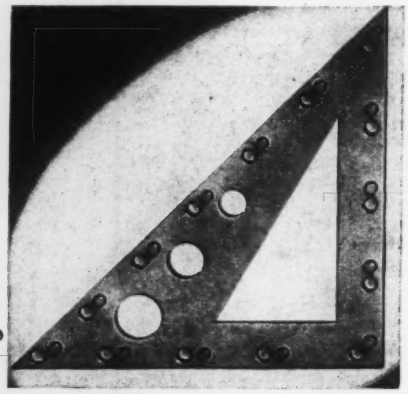
Item	Quantity	Government Estimate	Unit Prices (1)	Unit Prices (2)
37. Spec. bitum. filler, type C	130,000 lb.	.13	12	.15
38. 24" C I bell & spigot pipe, cl. B.	17,000 lb.	.13	.08	.10
39. 24" C I pipe fittings, cl. B	7,100 lb.	.19	.16	.19
40. 18" C I bell & spigot pipe, cl. B.	1,800 lb.	.13	.08	.10
41. 18" C I pipe fittings, cl. B	530 lb.	.23	.16	.15
42. Grills over air vent pipes	Sum Job	156.00	700.00	180.00
43. 6" round precast porous concrete drain pipe	10,300 lin. ft.	1.27	1.20	.91
44. 3" & 4" C I bell & spigot drain pipe.	15,900 lb.	.12	.12	.14
45. Pipe hand rail, dam gallery	775 lin. ft. of pipe	.50	1.00	1.73
46. C I brackets for pipe rail in dam gallery	173 each	2.05	1.00	1.02
47. Pipe railing	4,500 lin. ft. of pipe	.80	3.90	1.73
48. 48" CI bell & spigot sluiceway pipe	220,000 lb.	.41	.055	06
49. 48" C I flanged pipe, cl. B	43,300 lb.	.17	.10	.16
50. 48" by 72" c i sluiceway pipe bell-mouth	19,500 lb.	.31	.23	.27
51. 48" pipe couplings	4 each	342.00	230.00	345.50
52. 48" C I pipe fittings	22,000 lb.	.24	.15	.17
53. 48" motor oper. non-rising stem, double disc, brass-trimmed, gate valves	2 each	6,585.00	9,000.00	10,982.50
54. 48" motor oper. free discharge valves	2 each	17,070.00	14,800.00	17,168.50
55. 8" C I pipe	10,430 lb.	.10	.07	.15
56. 1½" brass pipe & fittings	30 lb.	1.43	2.50	8.39
61. Trashrack rake, hoist & car	Sum Job	47,350.00	13,000.00	14,407.00
62. 3" extra heavy steel pipe and fittings	600 lb.	.22	.17	.20
63. 3" brass gate valve	4 each	75.00	30.00	37.00
64. Passenger elevator in dam	Sum Job	29,800.00	18,000.00	32,338.00
65. Galvanized iron gratings	140 sq. ft.	2.10	2.00	3.78
66. Hollow metal and fire protection doors in dam	Sum Job	500.00	1,200.00	1,165.00
67. Picket gates, dam	Sum Job	600.00	1,000.00	1,275.00
68. Anchor, bracket, gantry crane	Sum Job	3,600.00	2,500.00	2,882.00
69. 3 main unit penstocks and 1 service unit penstock	Sum Job	343,400.00	270,000.00	346,984.00
70. Bulkheads, penstock No. 3	2 each	1,340.00	3,000.00	1,654.00
71. Rails, gantry crane track and head gate hoist tracks	194,000 lb.	.11	.16	.06
72. Trashrack steel	622,000 lb.	.14	.12	.20
73. Miscellaneous steel in dam	105,600 lb.	.21	.30	.28
74. Separate floor finish in powerhouse	Sum Job	1,550.00	6,000.00	2,088.00
75. Struct. steel, powerhouse	442,000 lb.	.14	.09	.11
76. Switchyard steel structure	365,000 lb.	.18	.14	.21
77. Misc. steel, powerhouse	48,000 lb.	.25	.33	.28
78. Wire grille partitions in powerhouse	993 sq. ft.	1.30	.50	2.25
79. C I spiral stairs, powerhouse	94.5 ft. of height	26.00	50.00	44.79
80. C I safety trds, powerhouse	248 lin. ft.	1.23	4.00	3.35
81. C I thresholds, powerhouse	106 lin. ft.	1.00	4.00	1.87
82. Misc. C I, powerhouse	12,100 lb.	.25	.20	.57
83a. Terra cotta furring and partitions in powerhouse—12"	366 sq. ft.	.80	.80	.69
83b. Same, 8"	336 sq. ft.	.50	.65	.56
83c. Same, 6"	8,900 sq. ft.	.38	.55	.43
83d. Same, 4"	5,500 sq. ft.	.30	.50	.31
83e. Same, 3"	822 sq. ft.	.29	.45	.30
84. Metal lath in powerhouse	660 sq. yd.	.50	2.00	2.46
85. Cmt. plaster, powerhouse	815 sq. yd.	1.00	1.10	2.47
86a. Gypsum plaster, powerhouse—two coat work	600 sq. yd.	1.14	1.90	1.76
86b. Gypsum plaster, powerhouse—three coat work	1,074 sq. yd.	1.50	2.00	2.12
87a. Tile work in powerhouse—quarry tile flooring	14,100 sq. ft.	1.88	.85	.90
87b. Tile work in powerhouse—quarry tile base separate	300 lin. ft.	1.40	.85	.72
87c. Tile work in powerhouse—quarry tile wainscot, including base	3,440 sq. ft.	1.94	1.00	2.39
87d. Tile work in powerhouse—quarry tile stair treads 4 risers	210 lin. ft.	2.12	2.00	4.18
87e. Tile work in powerhouse—quarry tile thresholds	100 lin. ft.	1.50	1.65	2.77
87f. Tile work in powerhouse—glazed terro cotta wall ashlar	5,200 sq. ft.	2.30	3.00	3.36
88. Suspend. ceiling, powerhouse	620 sq. yd.	5.20	5.00	4.15
89. Caulking in powerhouse	Sum Job	240.00	300.00	51.00
90. Steel lockers in powerhouse	30 each	23.00	25.00	24.83
91a. Glass in powerhouse—plate	195 sq. ft.	2.40	1.45	1.31
91b. Glass in powerhouse—clear	49 sq. ft.	.70	.75	.63
91c. Glass in powerhouse—Florentine	330 sq. ft.	.75	.75	.60
91d. Glass in powerhouse—block	3,625 sq. ft.	2.20	1.00	2.80
92a. Toilets and shower bath stalls, powerhouse, marble 1¼"	220 sq. ft.	4.20	8.00	4.84
92b. Same, marble 1" thick	126 sq. ft.	3.50	7.50	3.47
92c. Same—wood doors for toilets	11 each	37.00	45.00	49.09
93. Wood office partitions in powerhouse	75 lin. ft.	[15.00	38.00	29.45
94. Linoleum in powerhouse	328 sq. yd.	3.75	4.00	3.61
95a. Cover plates for expansion joints in powerhouse and switchyard—steel plate	6,833 lb.	.47	.20	.28
95b. Same—pressed steel	220 lb.	.75	.50	.30
96. Aluminum rail'g, powerhouse	450 lin. ft.	5.80	8.00	13.90
97. Sheet brass	125 lb.	1.10	2.00	.92
98. Tile flue	Sum Job	850.00	700.00	554.00
99. Gypsum roof slab over generator room	Sum Job	10,680.00	7,000.00	12,206.00
100. Asphalt built-up roofing on powerhouse and on stair housing on dam	2,750 sq. yd.	1.80	1.75	1.96
101. Copper flashing, powerhouse	2,450 lb.	1.05	.60	.38
102. Hollow metal frames and trim in powerhouse	Sum Job	2,740.00	2,500.00	3,254.00
103. Wood and main entrance doors of powerhouse	Sum Job	4,100.00	6,000.00	6,441.00
104. Automatic fire doors in powerhouse	3 each	135.00	130.00	111.33
105. Steel rolling doors in powerhouse	2 each	1,780.00	1,600.00	2,069.00
106. Finish hardware, powerhouse	Sum Job	1,900.00	2,600.00	2,190.00
107. Standard gauge railroad track, powerhouse & switchyard	404 lin. ft.	6.60	10.00	17.69
108. Stop-log gates & guides	Sum Job	25,780.00	25,000.00	30,139.00
109. Stop-log hoist and track	Sum Job	8,700.00	20,000.00	8,320.00
110. Passenger elevator, in ph	Sum Job	21,875.00	15,000.00	23,209.00
111. Rails for powerhouse crane	37,300 lb.	.12	.07	.07
112. Painting in powerhouse	Sum Job	7,100.00	2,200.00	7,014.00
113. Unwatering system	Sum Job	12,750.00	20,000.00	10,360.00
114. Penstock equaliaing system	Sum Jcb	30,940.00	40,000.00	32,355.00
115. Raw water system	Sum Job	28,550.00	35,000.00	35,992.00
116. Sump pump piping	Sum Job	3,515.00	6,000.00	3,482.00
117. Piezometer piping	Sum Job	7,920.00	12,000.00	8,348.00
118. Insulating oil purifying equip. and distribution piping	Sum Job	16,180.00	20,000.00	23,860.00
119. Governor and lubricating oil purifying equip. and distribution piping	Sum Job	7,650.00	10,000.00	9,969.00
120. Air compressors and distribution piping	Sum Job	4,700.00	5,000.00	6,840.00
121. Sump pumps & oil drain pump	Sum Jcb	8,470.00	10,000.00	8,729.00
122. Water treatment plant	Sum Jcb	19,400.00	15,000.00	14,404.00
123. Co₂ fire protection system	Sum Jcb	24,630.00	15,000.00	26,268.00
124. Transformer fire protect. sys	Sum Jcb	32,170.00	25,000.00	28,239.00
125. Oil storage tanks	Sum Jcb	13,220.00	25,000.00	10,367.00
126. Gas.-elec. generator set & acces.	Sum Jcb	9,050.00	10,000.00	7,270.00
127. Fire extinguisher	Sum Jcb	30.00	30.00	25.00
128. Heating system	Sum Jcb	23,000.00	30,000.00	27,302.00
129. Vent. and air cond. sys	Sum Jcb	66,200.00	75,000.00	62,540.00
130. Domestic water sup. system	Sum Jcb	3,875.00	10,000.00	6,548.00
131. Powerhouse drainage system	Sum Jcb	20,200.00	20,000.00	18,372.00
132. Ph fire protect. system	Sum Jcb	2,200.00	3,000.00	2,661.00
133. Sanitary plumbing	Sum Jcb	6,400.00	7,000.00	22,450.00
134. Imhoff tank	Sum Jcb	1,985.00	1,200.00	5,481.00
135. Steel conduit	218,000 lb.	.48	.25	.52
136. Transite conduit	100 ft.	1.75	5.00	5.47
137. Cable trays & term. rm. struct.	Sum Job	36,270.00	55,000.00	55,698.00
138. Insulated wires and cables	72,690 lb.	2.09	.90	1.30
139. 13,800 volt connections and equip.	Sum Job	76,600.00	125,000.00	122,344.00
140. Motor control and misc. service equip	Sum Job	24,775.00	20,000.00	49,266.00
141. Light fixtures & cabinets	Sum Jcb	26,000.00	40,000.00	30,518.00
142. Receptacles and plugs	Sum Jcb	4,410.00	6,000.00	5,337.00
143. Telephone equipment	Sum Jcb	8,200.00	15,000.00	6,569.00
144. Copper busses & connections	Sum Jcb	12,400.00	25,000.00	13,001.00
145. Grounding system	24,400 lb.	1.03	1.00	3.22
146. U. S. engr lab. bldg compl. with util. & in operating order and outside util. to office bldg	Sum Job	5,900.00	10,000.00	6,322.00
147. Flagpole	Sum Jcb	650.00	500.00	690.00
148. Common excavation, highway	183,200 cu. yd	.45	.25	.60
149. Rock excavation, highway	34,500 cu. yd.	3.25	1.25	1.50
150. Overhaul, highway	2,472,000 sta. yd.	.005	.005	.01
151. Base course: cr. stone, hwy	75,625 sq. yd.	1.50	1.00	1.67
152. Bituminous primer, highway	22,700 gal.	.16	.20	1.20
153. Asphaltic concrete, highway	7,250 ton	7.50	7.50	10.52
154. Guard rail, highway	10,500 lin. ft.	2.25	2.00	1.79
155. Da n/raw water system	Sum Jcb	1,100.00	1,000.00	6,295.00
156. Con tensation prevent. coatg	400 gal.	4.70	6.00	9.50
157. Bitum. tack coat, highway	7,200 gal.	.15	.11	.20
Government Furnished Equipment To Be Transported and Installed				
G-1. Hea lgate frames and guides	666,000 lb.	.056	.04	.13
G-2. 7 hea lgates & 5 hoists	Sum Jcb	21,500.00	10,000.00	10,097.00
G-3. 9 radial gates includ. embedded steel, guides and machy, and 1 bulkhead gate	Sum Job	75,700.00	45,000.00	100,489.00
G-4. 2 regulating gates, including embedded steel, guides and machy, and 1 bulkhead gate	Sum Job	14,570.00	6,000.00	20,583.00
G-5. Gantry crane	1 each	14,520.00	4,700.00	17,018.00
G-6. Powerhouse crane	1 each	33,400.00	11,000.00	24,141.00
G-7. 50,000 hp. turbine & governors	2 each	26,700.00	55,000.00	64,374.00
G-8. 2,900 hp. turbine & governor	1 each	2,575.00	4,700.00	5,477.00
G-9. Hydraulic gauge boards	Sum Job	1,540.00	3,000.00	2,463.00
G-10. A. Bench, instrument, relay & aux. contr. switchboards with water level transmitters & master clock with load & frequency contr. equip	Sum Job	13,500.00	4,200.00	4,585.00
G-10. B. Bench, instrument, relay & aux. contr. switchboards with water level transmitters & master clock without load & frequency control equip	Sum Job	12,450.00	4,000.00	4,448.00
G-11. Excitation cubicles (payment incl. with items G-20 & G-21)				
G-12. Neutral circuit breakers and neutral reactors	Sum Job	2,450.00	890.00	4,756.00
G-13. 2,300 volt station service switchboard and service unit surge protection	Sum Job	3,280.00	1,900.00	1,609.00
G-14. 460 volt station service switchboard and transformers	Sum Job	1,600.00	2,300.00	3,388.00
G-15. 208–120 volt lighting distribution switchboard and lighting transformers in ph. & dam	Sum Job	515.00	1,500.00	1,540.00
G-16. Battery, charging equip. & D.C. distribution and battery control board	Sum Job	1,100.00	1,100.00	1,602.00
G-17. Main power transformers	Sum Job	16,200.00	7,500.00	48,634.00
G-18. Service transformers	Sum Job	1,420.00	975.00	2,053.00
G-19. Switchyard switching, metering, and protect. equip	Sum Job	15,050.00	11,500.00	49,540.00
Government Furnished Equipment To Be Transported				
G-20. Main unit generators	2 each	12,200.00	8,600.00	3,696.50
G-21. Service unit generator	1 each	825.00	2,000.00	214.00

New Aids to the Constructor

MANUFACTURERS' LATEST DEVELOPMENTS IN EQUIPMENT AND MATERIALS

"Floating" Triangle

A new one-piece triangle employs integral embossed buttons to make the lower surface clear the drawing paper by about .020 in. This "floating" instrument is said to save a draftsman's time by pro-



viding an ideal fingerlift at inside and outside edges, avoiding ink smears and minimizing smudges. As each "Instrumaster" 45-deg. triangle has a 30-60-deg. triangular opening, shifting from one to the other is eliminated.

This floating triangle, of clear non-inflammable plastic stock, guaranteed against warpage, is available in 4, 6, 8, 10 and 12-in. sizes, in both 45 and 30-60-deg. types.—*Instrumaster Industries, Inc., Greenwich, Conn.*

Dual Batching Plant

A new development for roadbuilders, providing for dual batching of aggregates, has an aggregate bin of portable section type, of 100 cu. yd. capacity, divided into three compartments, with hinged leg sections for fast erection and moving. Two multiple material batchers of 34E paver-batch capacity are so located that a single operator can handle both batchers.

The batchers, discharging simultaneously into the separate compartments of two-batch trucks, require only one spot in the aggregate plant and are said to effect a cost saving.—*The C. S. Johnson Co., Champaign, Ill.*

Gypsum Sheathing

Well timed to free more lumber for housing and vital construction, a new sheathing has been developed with an asphalted-gypsum weather-proof core. Rigorously tested, this U. S. G. sheathing proved to have a water absorption of only 3.4 percent by weight, and to show no buckling, warping or opening up of the joints; it is said to have remarkable bracing strength.

One man can easily handle a sheet of the sheathing, which has tongue-and-grooved edges, and a special water-resistant "Tripleseal" treatment on face and back. This sheathing also has fireproof qualities.—*United States Gypsum Co., Chicago, Ill.*

Two Drafting Instruments

The transparent acrylic plastic, Plexiglas, is used in two new drafting aids, a hatch-liner and a slot-letter. The hatch-liner consists of a 45-deg. triangle and a small, irregular, octagonal center piece, numbered to indicate the positions in which it can be placed for desired spacing of section lines.

With the slot-letter, a free-hand lettering guide, lettering is done directly through one of the slots, with the aid of reference lines.—*Dolgorukov Manufacturing Co., Washington, D. C.*

Folding Saw-Horse

Only four simple operations are needed to fold a sturdy saw-horse down to 8 x 8 x 42-in. size for easy transportation. Its cadmium-plated hardware is out of the way and will not nick tools nor loosen through usage. The saw-horse has a 2 x 6 x 42-in. white pine top and a 9 x 36-in. tool tray.—*Unique Tool Products Co., 4632 North Clark St., Chicago, Ill.*

Tube Coupling

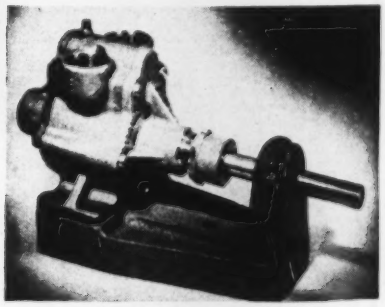
"Ten second" joining and disconnecting of individual sections of flexible tubing are said to be possible with Spiratube, a non-collapsible, retractable tubing with a built-in Warner coupling. The coupling, a flat spring steel collar, may be compressed to slip inside the end of another section and then released to form a strong, tight joint.

The coupling is covered with long-fiber duck fabric, processed fire-resistant and coated with a tough thermoplastic. As there is no exposed metal, sparking hazards are eliminated.—*The Warner Brothers Co., Spiratube Division, Bridgeport 1, Conn.*

Pipe Locator

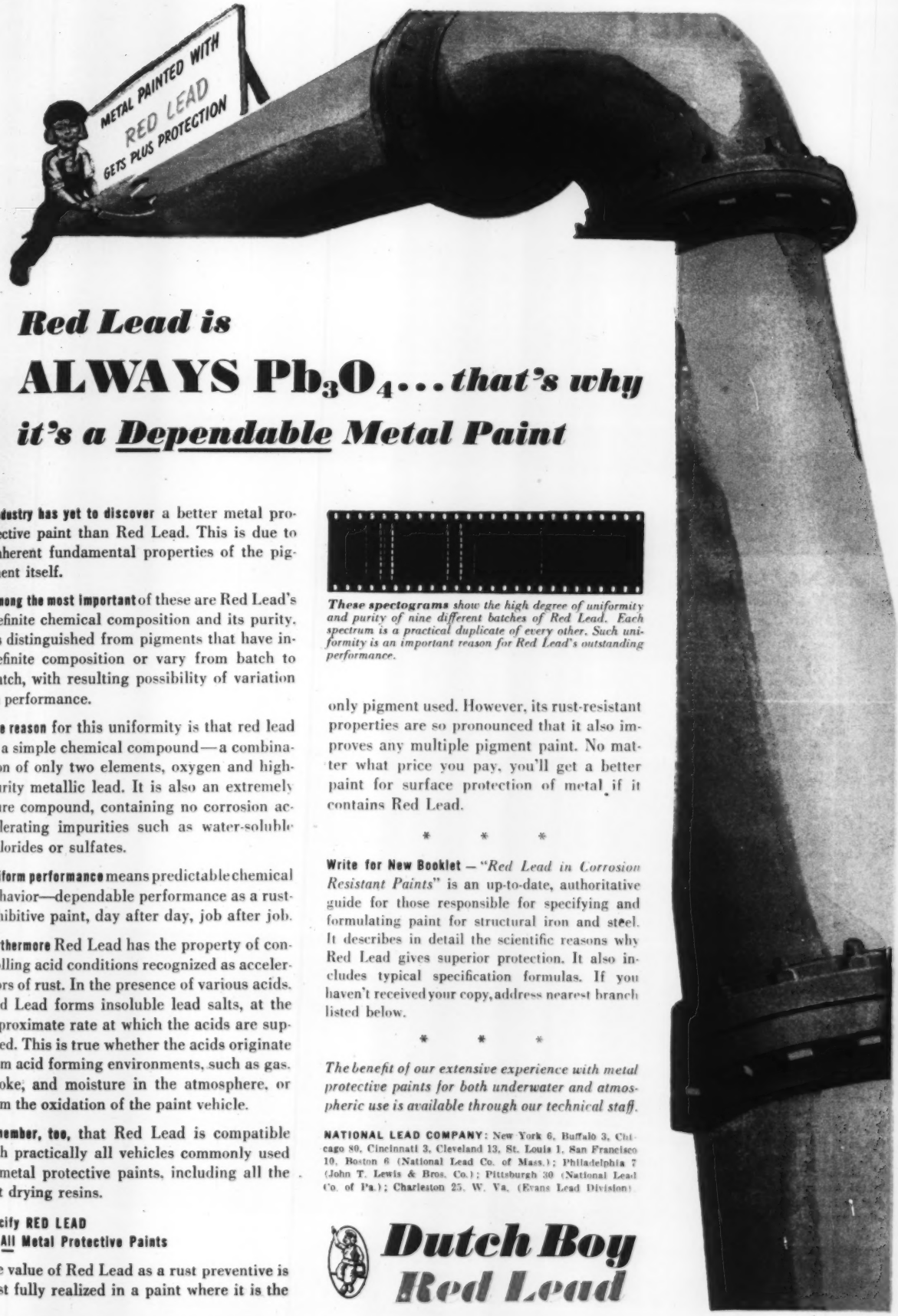
Contained in walnut cabinets with convenient carrying handles, the Wahlquist pipe locator, Model 112, transmitter and receiver units, locates pipe by a signal picked up in its vicinity. Weighing only 8 lb. together, these units are said to be extremely rugged; headphones are furnished with the receiver.

The transmitter supplies a test signal to the pipe or conduit, and remains stationary. The receiver consists of an internal pickup coil and battery-operated 3-stage amplifier.—*Nilsson Electrical Laboratory, Inc., 103 Lafayette St., New York 13, N. Y.*



Gearless Pump

Designed to eliminate gear jamming and stripping, a double-impeller gearless



Red Lead is
ALWAYS Pb_3O_4... *that's why it's a Dependable Metal Paint*

Industry has yet to discover a better metal protective paint than Red Lead. This is due to inherent fundamental properties of the pigment itself.

Among the most important of these are Red Lead's definite chemical composition and its purity, as distinguished from pigments that have indefinite composition or vary from batch to batch, with resulting possibility of variation in performance.

The reason for this uniformity is that red lead is a simple chemical compound—a combination of only two elements, oxygen and high-purity metallic lead. It is also an extremely pure compound, containing no corrosion accelerating impurities such as water-soluble chlorides or sulfates.

Uniform performance means predictable chemical behavior—dependable performance as a rust-inhibitive paint, day after day, job after job.

Furthermore Red Lead has the property of controlling acid conditions recognized as accelerators of rust. In the presence of various acids, Red Lead forms insoluble lead salts, at the approximate rate at which the acids are supplied. This is true whether the acids originate from acid forming environments, such as gas, smoke, and moisture in the atmosphere, or from the oxidation of the paint vehicle.

Remember, too, that Red Lead is compatible with practically all vehicles commonly used in metal protective paints, including all the fast drying resins.

Specify RED LEAD
for All Metal Protective Paints

The value of Red Lead as a rust preventive is most fully realized in a paint where it is the only pigment used. However, its rust-resistant properties are so pronounced that it also improves any multiple pigment paint. No matter what price you pay, you'll get a better paint for surface protection of metal if it contains Red Lead.

***These spectograms** show the high degree of uniformity and purity of nine different batches of Red Lead. Each spectrum is a practical duplicate of every other. Such uniformity is an important reason for Red Lead's outstanding performance.*

* * *

Write for New Booklet — "*Red Lead in Corrosion Resistant Paints*" is an up-to-date, authoritative guide for those responsible for specifying and formulating paint for structural iron and steel. It describes in detail the scientific reasons why Red Lead gives superior protection. It also includes typical specification formulas. If you haven't received your copy, address nearest branch listed below.

* * *

The benefit of our extensive experience with metal protective paints for both underwater and atmospheric use is available through our technical staff.

NATIONAL LEAD COMPANY: New York 6, Buffalo 3, Chicago 80, Cincinnati 3, Cleveland 13, St. Louis 1, San Francisco 10, Boston 6 (National Lead Co. of Mass.); Philadelphia 7 (John T. Lewis & Bros. Co.); Pittsburgh 30 (National Lead Co. of Pa.); Charleston 25, W. Va. (Evans Lead Division)

Dutch Boy Red Lead

FOR CONCRETE VIBRATION ON EVERY TYPE OF JOB IT'S JACKSON 2 to 1

JACKSON FLEXIBLE SHAFT
Model FS-7A

A lightweight, easy-to-handle electric vibrator of wide adaptability. Will handle any of our standard vibrator heads up to 2⅜" x 18⅝" with shafts up to 21' long. Universal motor, 115 volt AC or DC. Frequency 7,000 to 10,000 V.P.M. Available with shaft lengths of 24", 36", 7', 14' and 21'. Skid type handle.

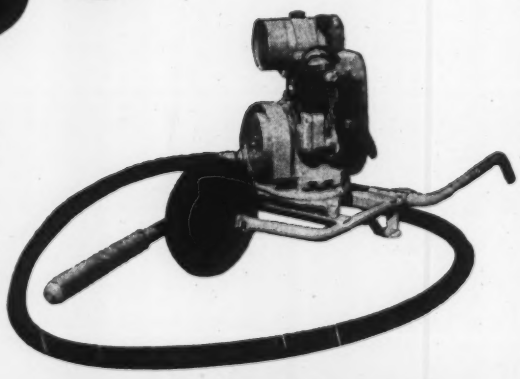
You state your concrete vibratory problem, and we'll supply the answer and lay you 2 to 1 that the JACKSON equipment we recommend will not only do the best possible job in the shortest possible time, but will also be the most dependable, trouble-free vibratory equipment you have ever owned. The line covers the entire field of concrete construction.

General Construction · Light Construction · Mass Concrete · Hard-to-get-at Places · Form Vibrating · Floors, Streets and Highways · Pipe Manufacturing · Movement of Materials · Vibratory Tables, etc.

Write for complete information and recommendations or the name of the nearest JACKSON distributor where this equipment may be seen.

JACKSON HYDRAULIC
Model HS-A1

A husky, dependable concrete vibrator for general use. Oil powered, gas engine hydraulic pump drive. 4000 to 7000 V.P.M. Head — 2¾" x 21". Quickly fitted with head for wet or dry rubbing, drilling, etc. Balanced for easy lift. Drop handles for easy hose disposal.



JACKSON FLEXIBLE SHAFT
Model FS-6A

A very dependable independent unit, gas engine powered. Up to 7500 V.P.M. 3 heads for thick and thin sections. Flexible shafting in 7 ft. to 14 ft. lengths up to 28 ft. Automatic clutch. Swivel base. Wheel barrow optional. Available with grinding and other attachments.

ELECTRIC TAMPER & EQUIPMENT CO.
LUDINGTON MICHIGAN

pump has standard 1-inch connections and a built-in driveshaft bearing and base. The double impellers are made of several layers of a pressure-vulcanized, laminated material and will pump in either direction; they pass grit, sludge, etc., without damage to the bronze pump body and may be easily replaced when the 6-screw face plate is removed.

The ECO pump can be mounted at any angle, and will not require adjustment or lubrication. Its built-in driveshaft bearing is said to do away with side pull, whether used with belt drive and pulley or with a head-on coupling. Pump capacities range from 7.5 gpm. at 600 rpm. to 23 gpm. at 1,800 rpm.—*ECO Engineering Co., Dept.* 20, 12 *New York Ave., Newark, N. J.*

Form-Holding Method

Forms held in position with steel strapping for pouring cement to resurface columns result in improved safety for the operator and more uniform finishing, it is claimed. This steel-strapping technique enabled a crew to finish eleven columns in one day, compared to four using another method. No shoring is required.

The ¾-in. wide, .025 in. thick steel strap was applied with a Gerrard even-tensioning Steelbinder tool.—*A. J. Gerrard Co., Chicago, Ill.*

Fluid Drive Coupling

Adaptable to wide use on hoists, winches, conveyor systems, etc., a fluid drive coupling operates on the Vulcan-Sinclair principle that eliminates both a transmission and differential mechanism, it is announced. The self-contained unit, of three basic parts, can be installed directly on the shaft of any engine or electric motor.

This Firebaugh hydraulic oil coupling engages and disengages without human control, and slippage is said to be eliminated. It is completely enclosed, which prevents entrance of dirt and dust.—*Toolcraft Manufacturing Co., Huntington Park, Calif.*

The last roundup

YOUR FINAL CHANCE to ENTER and WIN

2 Big Contests

SPONSORED BY

PITTSBURGH EQUITABLE METER DIVISION

ROCKWELL MANUFACTURING CO.

TO STIMULATE THINKING ABOUT THE COMMUNITY BENEFITS RESULTING FROM

100% METERING

All Entries Must Be Postmarked Not Later than Aug. 31, 1946

CONTEST NO. 1

Complete the last line of this jingle

Water works systems should not be neglected,
All other utilities are meter protected.
When water is wasted, costs run high;
The mounting deficit makes taxpayers cry.
100% metering is the only fair way,

This one's a snap—the only meter you need to understand is found in poetry. Study the tips listed on this page. Then write an informative last line for the jingle. As an example, the missing line could read:

"To charge consumers, make water plants pay."

You can submit as many last lines as you wish.

PRIZE LIST

1st Prize—$500.00	3rd Prize—$100.00	10 Consolation Prizes
2nd Prize—$250.00	4th Prize—$ 50.00	of $10.00 each

CONTEST NO. 2

Write a paper not exceeding 2,000 words in length on the subject

"How A Community Is Benefited By Metering All Services"

Come on you water works superintendents, municipal officials and engineers; this subject is made to order for you. Either write about your own universal metering experience or outline your theories on the advantages of metering all services. Logic and clear thinking will count as much as past metering experience.

Contestants will, at the discretion of the Editor, be offered a $25.00 cash release fee for the use of their papers in the Pittsburgh-Empire Water Journal.

PRIZE LIST

1st Prize—$500.00	3rd Prize—$100.00	10 Consolation Prizes
2nd Prize—$250.00	4th Prize—$ 50.00	of $10.00 each

TIPS ON ADVANTAGES OF 100% METERING

Metered consumers only pay for the water that is used—not for someone else's waste.

Metering discourages water waste—often cuts per capita distribution in half—conserves power, lowers treatment costs.

100% metering, by eliminating extravagant use of water, frequently curtails the need for costly added sources of supply.

By metering all services the burden caused by excessive wasted water on overloaded sewage disposal systems can be relieved.

Meters produce added revenue, usually enough to cover initial investment, maintenance costs and depreciation.

The meter system provides the only fair and equitable basis for apportioning water charges to all consumers.

CONTEST RULES AND REGULATIONS

Everyone is eligible to participate except employees and members of their families of any DIVISION or SUBSIDIARY of ROCKWELL MANUFACTURING COMPANY and their Agents.

All entries must be accompanied by coupon clipped from any contest announcement. Only one coupon is required to identify a contestant who submits a number of entries at the same time. Write on one side of paper only. *DO NOT* put name or address on any entry. An executed coupon will serve as contestant's identification. Contests close August 31, 1946. Entries must be postmarked on or before that date.

Winners names in both contests will be posted in Pittsburgh-Empire Meter exhibit booths at the fall water works conventions. Checks will be mailed to winning contestants immediately upon completion of judging.

All entries will be impartially judged by the following:

WILLIAM W. BRUSH, Editor of Water Works Engineering
JAMES H. KENNON, Managing Engineer, Bureau of Water, Pittsburgh, Pa.
ALBERT E. PAXTON, Publisher of Engineering News-Record and Construction Methods

The decisions by the judges will be final and no entries will be returned. In case of ties, duplicate prizes will be awarded.

USE THE COUPON

Fill in coupon with name and address. Clip, pin or staple to entry sheet or sheets. Upon receipt a code number will be assigned to each contestant and this number alone will appear when subject matter is being considered by the board of judges. No entries accepted without coupon.

PITTSBURGH EQUITABLE METER DIVISION B
ROCKWELL MANUFACTURING CO
400 N. Lexington Ave., Pittsburgh 8, Pa.

Attached find my entry or entries for
CONTEST NO. 1 ☐ CONTEST NO. 2 ☐
Check in boxes provided. Where entries are submitted in both contests, check both boxes.

Your Name ..... Title .....
Business Connection .....
Street .....
Town ..... State .....

CONTESTS CLOSE AUGUST 31 1946

Tear Out THIS COUPON NOW!

Both are tough . . . but ONE is tougher!

WHEN TWO MASTIFFS TANGLE in a snarling pinwheel . . . the result is never a draw. The dog with the extra staying power always wins the day.

EXTRA STAYING POWER, in wire rope as well as dogs, always pays off when the going gets rough. The extra stamina of Rochester wire rope shows up strong in the grind of daily operation . . . gives maximum protection against wear and tear.

ROCHESTER WIRE ROPES owe their extra stamina to the "four M's" that enter into their fabrication—MEN who are skilled craftsmen . . . working with MATERIALS of certified high strength and utility . . . using METHODS and MACHINERY that are strictly modern and exactly right for the precise and demanding work they were designed to do. All types, sizes, grades and constructions—preformed or standard—are available for prompt shipment. Rochester Ropes' engineers can advise you on your special problems of wire rope selection, use and maintenance. Inquiries invited.

LOCKED-IN LUBRICATION is forced by air pressure between individual wires. This process requires twice as much lubricant as is absorbed by other methods . . . protects against internal friction caused by rope passing over sheaves . . . assures longer life and better service from wire ropes made by Rochester.

ROCHESTER *Ropes*

CULPEPER, VIRGINIA

Branch Offices & Warehouses: *Birmingham, Houston, Jamaica, N. Y., San Francisco*

Manufacturers' Activities

ERNST GRUENWALD, with Lone Star Cement Corp. since 1926, has been made manager of the "Incor" and Technical Service branches of the company, succeeding Purd Wright. Mr. Gruenwald, an engineering graduate of the University of Vienna, has served as concrete designer and for a time was assistant to Duff Abrams. He has been in Lone Star's Technical Service branch, working with contractors and designers, since 1932.

DIRECTORS of Signal Mountain Portland Cement Co. have elected vice-president S. W. Storey, Chicago, to the presidency, succeeding the late John L. Senior. Howard Miller, Chicago, was elected executive vice-president. John L. Senior, Jr., New York was elected a director to succeed his father.

ROBERT W. WINTERS has been appointed manager of the West Central offices of the Portland Cement Association at Kansas City, Mo.

L. O. MCLEAN has been appointed sales manager of The General Excavator Co., Marion, Ohio, manufacturer of shovels, cranes, draglines and other material handling equipment. He joined the company in 1920 and succeeds Don B. Smith, elected vice-president of the Milwaukee Hydraulics Corp.

WILMS, WEAVER & Co., Detroit, Mich., has been dissolved. Mr. Wilms will operate as Walter H. Wilson & Co., specializing in general construction and marine equipment. Mr. Weaver will continue under the firm name of Charles Weaver & Co. handling steam turbine generator and general power plant equipment, diesel engines, etc.

THE ALLIED STEEL PRODUCTS, INC., Cleveland, Ohio, announce the appointment of The Taft Welding Equipment Co., 3171 Main Street, Springfield, Mass., as direct factory agents in the territory consisting of Connecticut, Rhode Island and Western Massachusetts. The company manufactures Bulldog Grip-Lugs, Mango Repointer Bars and "Excellov" Hard Surfacing Material.

EMERSON H. TODD has been appointed sales manager of American Cable and Hazard Wire Rope Divisions of American Chain & Cable Co., Inc., succeeding Frank W. Bemis, who resigned to enter another line of business in Omaha, Neb. George Gunther, with the company prior

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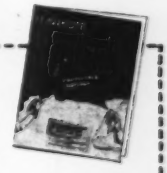

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to his service with the armed forces, has been appointed Chicago district manager for the wire rope divisions succeeding Mr. Todd.

GAR WOOD INDUSTRIES, INC., has expanded its manufacturing facilities by purchasing from the War Assets Administration the former Bendix plant in Wayne, Mich., it was announced by John J. Bergen, chairman, and Charles W. Perelle, president. The company will transfer all its Detroit operations to the new site with the exception of its body plant. Gar Wood will manufacture in its new plant hydraulic hoists, steel bodies, winches, cranes and derricks for motor trucks, hydraulic systems and attachments for bulldozers, scrapers and other tractor equipment; oil burners, gas burners, oil and gas-fired hot air heating units, oil and gas-fired boiler units, ventilating fans and hot water heaters.

JOHN C. DONNELLY previously associated with Mussens Canada Limited for many years has recently become connected with the Duke Equipment Co., Montreal, distributors of construction, roadbuilding and industrial equipment.

RAY E. ARNOLD has been appointed district representative for LaPlant-Choate Mfg. Co., Inc., at Portland, Ore., succeeding G. H. Taylor, who has been transferred to the main office of the company at Cedar Rapids, Iowa. Mr. Arnold has had considerable experience as a county engineer and as an engineer with the Minnesota State Highway Department. He will contact LaPlant-Choate distributors and users of LaPlant-Choate earth-moving equipment in Oregon, Washington and British Columbia.

SUPERIOR CONCRETE ACCESSORIES, INC., moved into their own new building, 4110 Wrightwood Ave., Chicago 39, Ill., July 1. Both office and plant are at the new location.

MARVIN GREENWOOD, general sales manager of The Celotex Corp., announces the following personnel changes in the company's sales division: E. C. Rautenberg, formerly manager of the Chicago office has been appointed assistant general sales manager with headquarters in Chicago. Mr. Rautenberg is succeeded by E. E. Dierking who comes to Chicago from Cleveland where he was manager of the Celotex branch office. George J. Dinges has resumed his position as manager of the Celotex Atlanta branch, and Allen Cassin becomes manager of the Cleveland branch.

L. S. RIEDEL has been appointed regional manager of the construction equipment division of the Worthington Pump and Machinery Corp., 748 Bruckner Blvd., Bronx, New York.

HERE, MR. BARUCH, are two aids for the action you recommend:

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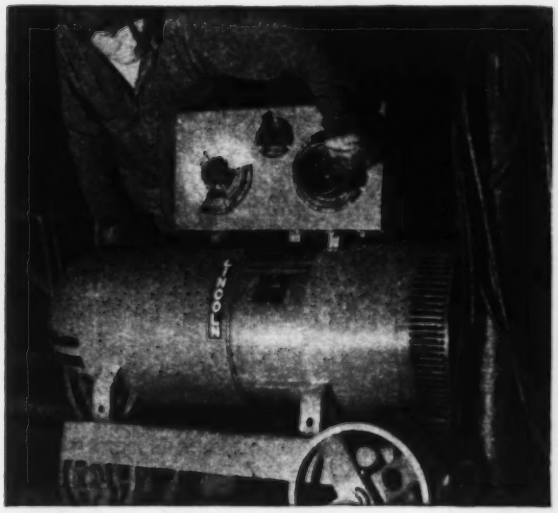

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With amperage supplied by the Lincoln "Shield-Arc" Welder, you get extra speed because you can select the right TYPE of arc and the right arc INTENSITY to match every thickness of metal and every welding condition . . . easily, quickly. Simplifies operation because control is self-indicating and continuous. Full details in Bul. 412.

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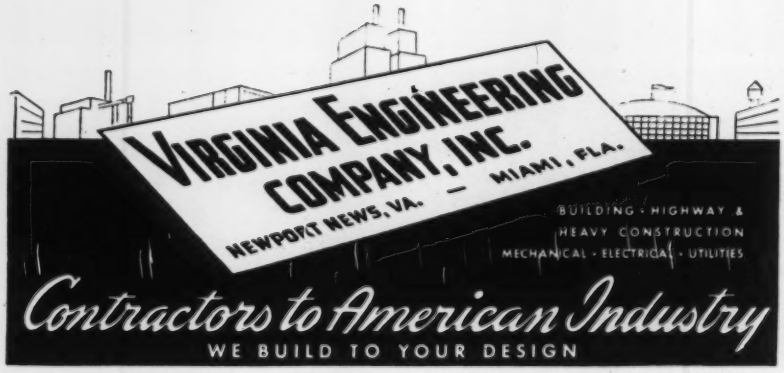
CHALLENGE IN A STAMP
May we tell you the entire story of Virginia Engineering Company? Write today.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Manufacturers' Publications

Material-Handling Machinery — (8-p. bulletin) Describes car shakeout with which two men can empty hopper-bottom roadroad cars of free-flowing bulk material in 1½ to 7 min. Field performance tests are outlined and typical application arrangements listed.—*Robins Conveyors, Inc., Hewitt Rubber Corp., Passaic, N. J.*

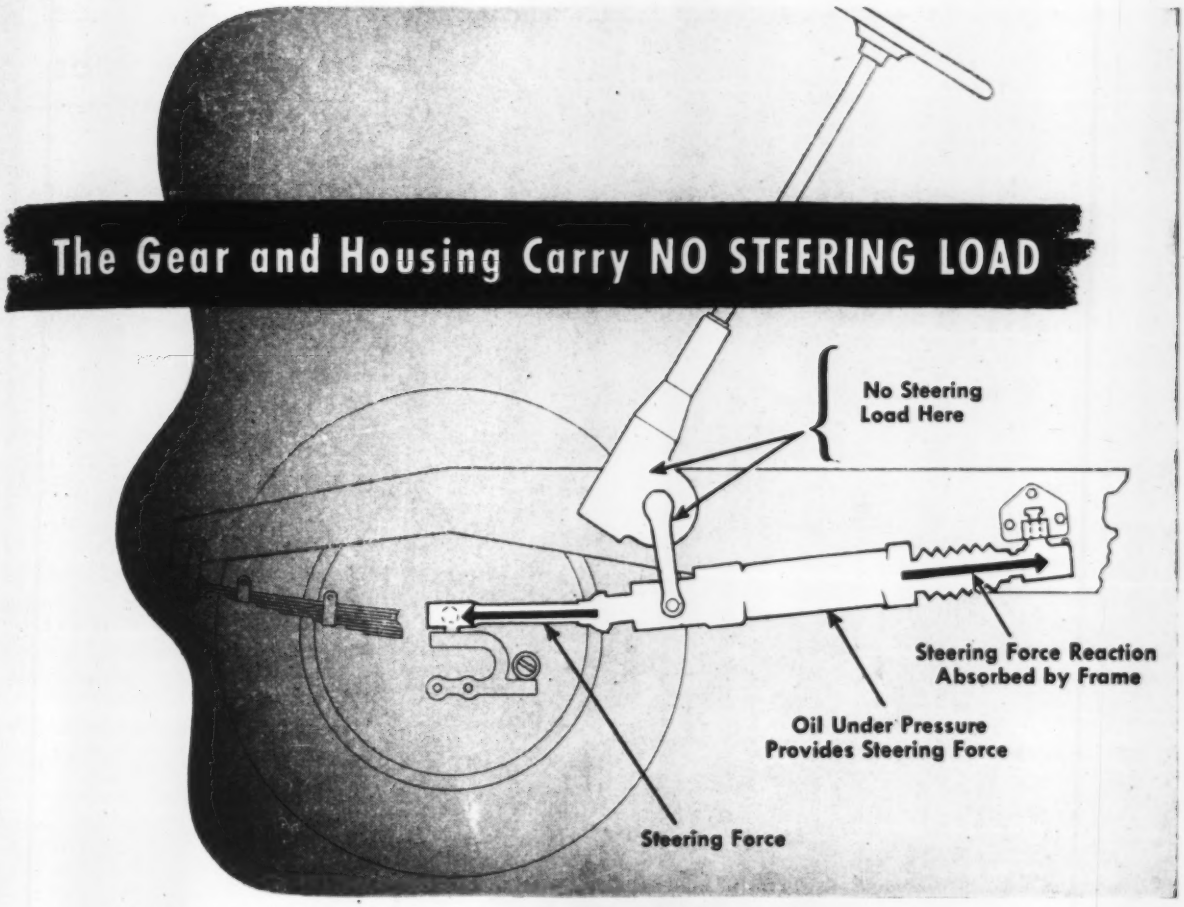
Tractor Loader—(24-p. bulletin) Features dozer-shovel and illustrates with large photographs and pen drawings actual operating conditions on wide variety of digging, earthmoving and material-handling jobs. It emphasizes unit's low overhead clearance and generally compact design for high maneuverability; high visibility; maintenance of tractor balance; smooth hydraulic control; and versatility made possible by easy interchangeability from shovel to bulldozer.—*Bucyrus-Erie Co., South Milwaukee, Wis.*

Concrete Densifier — (8-p. booklet) Covers action and benefits of Plastiment, recommended by manufacturer for use in concrete to improve watertightness, strength, surface hardness, and other characteristics.—*Sika Chemical Corp., Gregory Ave., Passaic, N. J.*

Arc Welding Accessories—(8-p. folder) Announces complete new line for welding trade. All items are identified with catalog numbers. They include face shields, electrode holders, cables, cleaning brushes, overalls, coats, pants, gloves, and aprons.—*Hobart Brothers Co., Troy, N. Y.*

Cutting Cast Iron—(16-p. circular) Tells how to cut with oxyacetylene flame. Included is discussion of proper types of equipment, preheating conditions, cutting positions, need of adequate protective clothing, proper oxygen and acetylene pressures, etc. It is intended to simplify methods, procedures and techniques.—*National Cylinder Gas Co., 205 W. Wacker Drive, Chicago 6, Ill.*

Fence Erection—(40-p. manual) Furnishes aid to contractors, fence superintendents and others responsible for installation and maintenance of chain link fence. Each step is described in logical sequence in accordance with current field practice. Tables, charts, diagrams and detailed drawings supplement text. —*Wickwire Spencer Steel Co., 500 Fifth Ave., New York 18, N. Y.*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No Steering Load Here
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Oil Under Pressure Provides Steering Force
Steering Force

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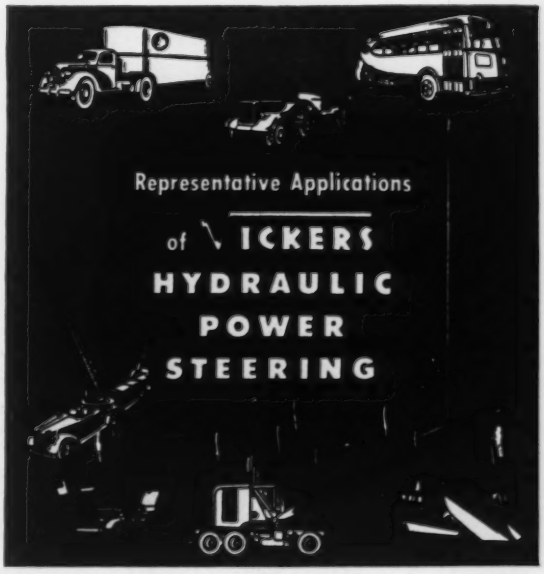

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Men and Jobs

Erick L. Erickson, who has been the bridge engineer for the Public Roads Administration Division Office in Atlanta, Ga., has been transferred to the Washington Office of Public Roads as assistant chief of the bridge division. Mr. Erickson went to Public Roads in 1941 as a bridge engineer, assigned to the district office in Montgomery, Ala. Before that, he was with the Louisiana Highway Commission as assistant state bridge engineer. He supervised the construction of several notable structures, including the bridges over the Chef Menteur and Rigolets Passes at New Orleans; the Atchafalya River at Krotz Springs and Morgan City and the Mississippi River near Baton Rouge, Louisiana.

E. L. Erickson

Mr. Erickson's earlier experience included service with the highway departments of North Carolina and Indiana and the Chicago and Western Indiana Railroad. He attended the State University of Iowa.

In recent months **A. M. Rawn,** chief engineer, Los Angeles County Sanitation Districts, has taken on additional responsibility because voters in three more districts have approved bond elections providing funds for sharing in the joint sewage disposal program. This brings up to eighteen the total number of districts with which Rawn's organization has undertaken contractural obligations. The total area involved is some 382 sq. mi. with a population of about 1,258,000. His present program includes provision for all of the San Gabriel Valley west of the river of that name except the northwest sections tributary to the Los Angeles system.

A. M. Rawn

His staff is now preparing plans for facilities to serve the increased area. Among the new requirements will be a second mile-long ocean outfall paralleling the existing one at White's Point which has established an outstanding record.

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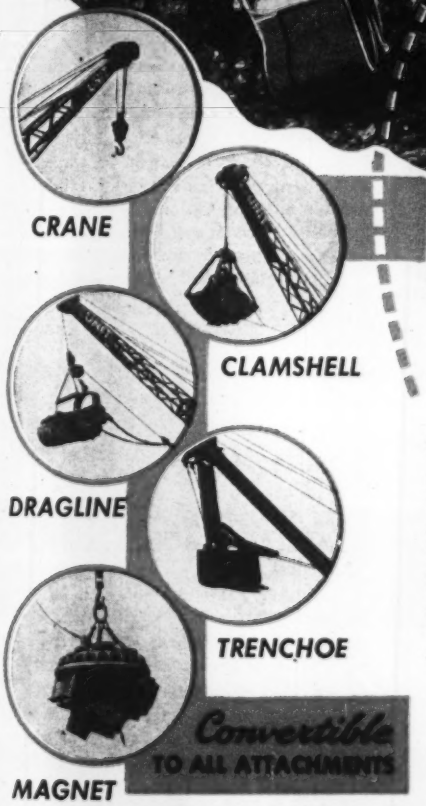

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Civilian Activity

Rolland W. Simpson, sanitary engineer, has joined Gilbert Associates, Inc., Engineers and consultants, in Reading, Pa., with offices in New York, Washington and Philadelphia. Prior to the war, he was an associate sanitary chemist with the Buffalo, N. Y., Sewer Authority.

R. W. Simpson

In 1942 he was with the Corps of Engineers, 4th Service Command, as resident field engineer at Kessler Field, Miss. While there he supervised the operation and maintenance of the sewage treatment plant, water supply, insect and pest control. In the latter part of the war he was transferred to Buckley Field, Colo., where he organized and headed the sanitary engineering section of the Post Engineer Training School. A graduate of Canisius College, Buffalo, N. Y., Mr. Simpson is a co-author of numerous publications concerning river pollutions, reduction of bacteria in sewage, methods of determining chloramine, and bio-filter operation.

Another recent addition to Gilbert Associates is **Lieut. Commander John G. Miller,** USNR, Purdue University graduate, who will be a mechanical engineer at Reading.

J. G. Miller

For the last four years, Mr. Miller has been in the Bureau of Ships, Navy Department. He supervised design of machinery and electric plants for about ninety ships, including landing craft, PT boats and other auxiliary vessels. He received a citation for his services. Prior to the war, Mr. Miller was employed for six years as a mechanical engineer with the Detroit Edison Co.

Henry E. Kendall, lieut. colonel, now on terminal leave from the Engineer Corps, U. S. Army, after four years, has been appointed chairman of the North Carolina State Unemployment Compensation Commission, Raleigh, succeeding Colonel A. L. Fletcher.

Hig